Chapter 6 BULL TROUT

6.1 Status

The status of Pacific Northwest bull trout (*Salvelinus confluentus*) populations have been under Federal agency review for over eighteen years. On September 18, 1985, the USFWS published a notice of review that designated bull trout as a candidate species. Several environmental groups petitioned bull trout for listing throughout its entire range under the ESA's endangered status in October 1992. In January 1994, the IDFG closed all Idaho waters to bull trout harvest except Lake Pend Orielle and the Lower Clark Fork River. In 1996, restrictive angling regulations protected most bull trout populations throughout the State of Oregon.

In 1994, the USFWS found that the 1992 petition was not warranted due to insufficient data regarding threats, status, and population trends of the Canadian and Alaskan population segments. However, the Columbia and Klamath River basins' population information was sufficient to warrant listing, and the USFWS listed bull trout populations in these basins as threatened in June 1998 (63 FR 31647).

Bull trout populations within this distinct population segment have declined from historical levels and are generally considered to be isolated and remnant. The USFWS rationale for Federal listing included habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, poor past management practices, and the introduction of non-native competitors such as brook trout (*Salvelinus fontinalis*) (63 FR 31647). Although some strongholds still exist, bull trout generally occur throughout the Columbia River basin in isolated subpopulations in headwater lakes or tributaries where migration has been precluded.

The USFWS began the 5-year status review of bull trout in January 2004. The purpose of the review is to ensure that the species has the appropriate level of protection under the ESA and to improve management and conservation of the species (USFWS 2004). During the status review, further work on the recovery plan for the Columbia and Klamath River basins was suspended. The public comment period for this process was extended to January 1, 2005. Completion of the review should occur in the spring of 2005 (USFWS 2004).

The USFWS designations for bull trout critical habitat do not include waterways in the action areas for this consultation (69 FR 59996).

6.1.1 Previous Biological Opinions and Ongoing Implementation Activities

1999 Biological Opinion

The *Biological Opinion on the Bureau of Reclamation Operations and Maintenance Activities in the Snake River Basin Upstream of Lower Granite Dam* (USFWS 1999) included three reasonable and prudent measures (RPMs) and associated terms and conditions for bull trout for Reclamation to address in order to comply with Sections 4(d) and 9 of the ESA:

1. Reduce the incidence of bull trout entrainment due to reservoir operations. The terms and conditions for this RPM are to:
    a. Immediately implement interim measures to reduce entrainment from project operations.
    b. Initiate studies necessary to develop long-term entrainment reduction solutions.
    c. Reinitiate consultation with USFWS based on the findings of the above investigations to implement long-term entrainment reduction solutions at Reclamation facilities.
2. Within existing authorities and voluntary partnerships, work toward ensuring reservoir operations do not result in de-watering of Reclamation reservoirs to the extent that adfluvial bull trout resident there during part of their life history are stressed or killed. The terms and conditions for this RPM are to:
    a. Initiate water quality monitoring efforts to determine minimum pool necessary to support adfluvial bull trout in Beulah, Deadwood, Anderson Ranch, and Arrowrock Reservoirs.
    b. Initiate an investigation of alternatives for creating a minimum fisheries pool in Reclamation reservoirs that now support resident/adfluvial bull trout.
    c. Implement a method to ensure that a minimum fisheries pool is available in Reclamation reservoirs where bull trout are resident in the Snake River basin under high, low, and average water year scenarios.
3. Investigate methods to provide safe fish passage around Reclamation dams for bull trout. The terms and conditions for this RPM are to:
    a. Initiate research necessary to evaluate feasibility of providing passage at Agency Valley, Anderson Ranch, Arrowrock, and other dams where bull trout are not able to complete their life history requirements because of blocked migration due to passage barriers.
    b. Reinitiate consultation based on the findings to implement a long-term bull trout passage solution at Reclamation facilities in the Snake River basin.

Conservation Recommendations of the 1999 biological opinion included:

1. Engaging land managers, water users, state agencies, and other affected parties in a dialogue aimed at formulating cooperative land and water management plans in watersheds surrounding Reclamation projects.
2. Continuing to participate in ongoing life history investigations for bull trout in the Malheur, Boise, Powder, and Payette systems.
3. Investigate opportunities (in combination with item 1 above) to establish a year-round flow in the North Fork Malheur River downstream from Beulah Reservoir and possibly in the Deadwood River downstream from Deadwood Dam.

The RPMs of the 1999 biological opinion were extended in 2001 to allow coverage for incidental take under the ESA through 2004. None of the RPMs were changed when the extension was implemented.

2001 Biological Opinion

The USFWS (2001) issued a biological opinion to address specific effects of the Arrowrock Dam valve rehabilitation project that began in 2001. Reclamation has completed this construction project; Reclamation discusses these multiple effects in its biological assessment (2000) and environmental impact statement (2001a). Although the RPMs in the 2001 biological opinion were specific to the Arrowrock Dam construction project, the first and second RPMs were identical to the 1999 biological opinion's second and third RPMs. The RPMs in the 2001 biological opinion for the Arrowrock Dam construction project included:

1. Within existing authorities and voluntary partnerships, work toward ensuring reservoir operations do not result in de-watering of Reclamation reservoirs to the extent that adfluvial bull trout resident there during part of their life history are stressed or killed. Terms and conditions for this RPM are to:
    a. Initiate water quality monitoring/modeling efforts to determine water quality parameters and conservation pool necessary to support adfluvial bull trout in Anderson Ranch and Arrowrock Reservoirs.
    b. Initiate an investigation of alternatives for creating a conservation fisheries pool in Arrowrock Reservoir.
    c. Implement a method to ensure that a conservation pool is available in Arrowrock Reservoir under high, low, and average water year scenarios.
2. Investigate methods to provide safe fish passage around Arrowrock Dam for adult and juvenile bull trout. Terms and conditions for this RPM are to:
    a. Initiate research necessary to evaluate feasibility of providing passage at Arrowrock Dam where bull trout are not able to complete their life history requirements because of blocked migration due to their inability to migrate upstream past the dam once they are entrained into Lucky Peak Reservoir.

   b. Reinitiate consultation based on findings to implement a long-term bull trout passage solution at Arrowrock Dam.

3. Initiate a capture and transport program in Lucky Peak to mitigate for entrainment. The term and condition for this RPM is to complete discussions with the USFWS and the IDFG on a plan to be implemented immediately to begin capture and transport of bull trout that are entrained at Arrowrock Dam.
4. Complete a water quality monitoring plan for the project. The term and condition for this RPM is to agree to and implement a detailed plan before the onset of the construction project through the year following its completion to ensure that adverse water quality conditions are detected in a timely manner.
5. Form a fish advisory group to advise on responsive actions and to aid in analyzing data collected during the project. The term and condition for this RPM is to create and carry out appropriate information and advisory meetings for this project. A fish advisory group that can convene quickly and/or on a regular basis is the best way to avoid major losses to bull trout or other fish and wildlife during the construction phase of the Arrowrock project.
6. Conduct population estimates in Arrowrock Reservoir prior to and following the construction project. The term and condition for this RPM is to create population estimates to determine the project impacts.
7. Continue radiotelemetry studies in Arrowrock and Lucky Peak Reservoirs. The term and condition for this RPM is to monitor movements and mortality of bull trout in the reservoir to determine vulnerability to capture and entrainment during and after the completion of this project.
8. Continue, as directed by the Fish Advisory Group, to operate weirs on the North and Middle Forks of the Boise River. The term and condition for this RPM is to operate weirs during the construction project. Weirs on the North and Middle Forks of the Boise River will help generate population estimates and allow the capture of bull trout and their transport if hostile conditions occur in the reservoir during the project.

Reclamation has initiated numerous tasks and studies in compliance with the terms and conditions of these two biological opinions. Table 6-1 and Table 6-2 show the specific terms and conditions, related studies and tasks performed for the Boise, Deadwood, and Malheur River watersheds, time periods, status updates, and available reports. This chapter provides information from these studies.

In addition, Reclamation has continued to work with the Boise, Malheur, and Wallowa-Whitman National Forests, Burns Paiute Tribe, and the ODFW to collect distribution, migration timing, population size, and environmental effects information for bull trout within the Boise, Deadwood, Malheur, and Powder River basins under these two biological opinions. This work is ongoing. Table 6-1 and Table 6-2 cite the available reports; Section 6.7 summarizes the general study results.

Table 6-1. Description of work completed for the 1999 and 2001 biological opinions (USFWS 1999, 2001) in the Boise and Deadwood River watersheds.

Biological Opinion	RPM and T&C [1]	Project or Task	Time Frame	Purpose	Status	Reports Available
1999	RPM 1, T&C b	Boise Basin Bull Trout Population Genetic Analysis	2000-2003	Describe the genetic population structure and diversity, evaluate entrainment risks and extent with the Arrowrock and Lucky Peak Projects.	Completed. Final report available.	Whiteley et al. 2003.
1999	RPM 2, T&C c, CR 2	Boise and Deadwood Rivers Population and Habitat Monitoring	1999-2002	Monitor trends in migration and abundance with changes in habitat and environment.	Completed. Final reports available. Cooperative monitoring still underway.	Salow 2004b, 2004d; Salow and Cross 2003.
1999; 2001	RPM 1, T&C b, RPM 7	Lucky Peak and Arrowrock Adult Telemetry Study	2002-2005	Document levels of entrainment, mortality, and migration patterns.	In progress, interim report available.	Salow and Hostettler 2004.
1999; 2001	RPM 1, T&C b, RPM 7	North Fork Boise River Juvenile Telemetry Study	2001-2003	Tag and track juvenile-size bull trout to determine movement patterns in the river system prior to reservoir rearing and in the reservoir during rearing.	Completed. Interim report complete. Final expected December 2004.	Hostettler 2003.
1999; 2001	RPM 2, T&C b, RPM 7	Arrowrock Reservoir Habitat Use and Prey Investigation	2003-2005	Tag and track bull trout to determine habitat used and principal prey base in the reservoir during rearing and overwintering.	Project proposal completed. Year one tracking in progress.	Stiefel 2003.
1999; 2001	RPM 2, T&C a, RPM 4	Water Quality Monitoring and Planning	2002-2005	Sample, analyze, and report water quality conditions where bull trout are present.	Completed.	USBR 2003b, 2004a, 2004c.
2001	RPM 3	Lucky Peak Trap and Transport	2000-current	Capture and return bull trout entrained through Arrowrock Dam into Lucky Peak Reservoir.	Completed 4 years. Interim report available. Annual work continues.	Salow 2002.
2001	RPM 5	Creation of Fisheries Advisory Team for Arrowrock	2001-2004	Create advisory team to help plan, implement, and monitor impacts of construction project on bull trout.	Completed. Meetings held annually. Progress reports submitted to team.	Salow 2003, 2004a .
2001	RPM 6, RPM 8	Arrowrock Population Estimates	1999-2006	Determine reservoir population changes related to construction and drawdown.	In progress. 5 years completed.	Salow 2001, 2004c.

1. RPM is Reasonable and Prudent Measure; T&C is Term and Condition; CR is Conservation Recommendation.

Table 6-2. Description of work completed for the 1999 biological opinion (USFWS 1999) in the Malheur River watershed.

RPM and T&C [1]	Project or Task	Time Frame	Purpose	Status	Reports Available
RPM 1, T&C a	Entrainment Investigations	1999-2003	Describe alternatives to reduce entrainment at Agency Valley Dam.	Completed. Final report available.	Memorandum to files.
RPM 1, T&C b	Entrainment Reduction	1999-2004	Describe measures taken to reduce entrainment from Agency Valley Dam.	Completed. Final reports available. Cooperative monitoring still underway.	Schwabe and Perkins 2003.
RPM 1, T&C c	Reinitiate Consultation	1999-2001	Notify USFWS of changes resulting from RPM 1 and T&C 2.	Completed.	Memorandum sent to USFWS.
RPM 2, T&C a	Beulah Reservoir Water Quality Modeling	1999-2003	Sample, analyze, and report water quality conditions.	Completed.	USBR 2002.
RPM 2, T&C a	Reservoir Habitat Use and Prey Investigation	1999-2004	Tag and track bull trout to determine habitat used and principal prey base in the reservoir during rearing and overwintering.	Completed.	Gonzales 1998; Schwabe et al. 2001, 2002; Schwabe and Perkins 2003; Petersen et al. 2003.
RPM 2, T&C b	Conservation Fishery Pool Investigation	1999-2004	Describe alternatives to prevent draining of Beulah Reservoir to low levels.	Completed.	USBR 2001b.
RPM 2, T&C c	Ensure Conservation Pool at Beulah Reservoir	1999-2004	Provide a conservation pool for Beulah Reservoir.	Reclamation leased 2,000 acre-feet in 2001.	Memorandum to USFWS.
RPM 3, T&C a	Provide Passage for Entrained Fish	1999-2004	Capture and return bull trout entrained through Agency Valley Dam into the North Fork Malheur River.	Annual trap and haul continues. Updates provided in annual reports.	Schwabe and Perkins 2003; Reclamation comments on USFWS Recovery Plan.

1 RPM is Reasonable and Prudent Measure; T&C is Term and Condition

6.2 Distribution

6.2.1 Historical Distribution

Bull trout were present throughout the Snake River basin and in the eastern section of Idaho upstream from Shoshone Falls. The species is reported to have been widely dispersed throughout the basin, limited only by natural passage and thermal barriers. In this drainage, their historical range approximates that of spring, summer, and fall Chinook salmon (Thurow 1987; Rieman and McIntyre 1993) and possibly included the Owyhee River basin and other tributaries upstream as far as Salmon Falls Creek. They are not known to have occurred in the Snake River upstream from Shoshone Falls, the Wood River system, Birch Creek, or any stream in Idaho that drains the Centennial Mountains between Henrys Lake and the Bitterroot Range. An isolated population exists in the Little Lost River near Howe, Idaho, between the Lost River and Lemhi mountain ranges (Batt 1996).

In eastern Oregon, bull trout were present in the Grand Ronde, Malheur, and Powder River systems, but were not known to occur in the Burnt River system. Data on the bull trout's historical distribution in the Malheur River drainage is limited and dates from the ODFW observations beginning in 1955 (Buchanan et al. 1997). Before the construction of dams, bull trout could access the Snake River from the Malheur and North Fork Malheur Rivers. Anadromous salmon and steelhead historically spawned in the upper Malheur River basin (NPCC 2002). The lower Malheur River was most likely too warm for bull trout spawning or juvenile rearing but would have provided migration and overwintering habitat (Hanson et al. 1990 in Buchanan et al. 1997).

The Snake Hells Canyon subbasin lies within the historical native range of bull trout, although no clear documentation of the historical distribution of bull trout within the subbasin exists (Nez Perce Tribe 2004). According to Buchanan et al. (1997), there is no historical documentation of bull trout in the Powder River basin prior to the 1960s. It is suspected that they were widespread in the upper Powder River drainage and seasonally connected to the Snake River. Historical information about the distribution of bull trout below Hells Canyon Dam in the mainstem Snake River was very limited (Chandler 2003). Buchanan et al. (1997) reported that the IDFG observed bull trout at the mouth of Sheep, Granite, Deep, and Wolf Creeks between Hells Canyon Dam and the Imnaha River.

The distribution of bull trout may have paralleled the distribution of potential prey such as whitefish and sculpins. In several river basins where bull trout evolved with populations of juvenile salmon, bull trout abundance declined when juvenile salmon prey declined or were eliminated (Ratliff 1992).

6.2.2 Current Distribution

The USFWS draft *Recovery Plan for Bull Trout* (2002) specifies 22 recovery units for bull trout in the Columbia River basin and uses suspected historical function to delineate them. Currently, work on this draft recovery plan has been suspended for the 5-year status review as described in Section 6.1, and critical habitat was not designated in any of the action areas. However, both the draft recovery plan and the critical habitat designation contain thorough discussions of habitat requirements. Use of these documents allows Reclamation to eliminate redundancy and to provide a framework for delineation based on the populations of bull trout that occur in the action areas and the past work that has been completed. Figure 6-1 shows the known bull trout distributions and upstream migratory, spawning, and rearing habitats in the middle and upper Snake River basins. The following sections describe the units and subunits that occur within the action areas.

Southwest Idaho Recovery Unit

The Southwest Idaho Recovery Unit includes the Boise, Payette, and Weiser River basins in Idaho delineated on the basis of biology and life history needs. The populations these watersheds support represent regional “metapopulations.” A metapopulation is a network of populations that have some degree of intermittent or regular gene flow among geographically separate units (Gilpin and Hanski 1991).

The Arrowrock Core Area includes the Middle Fork and North Fork Boise Rivers upstream from Arrowrock Dam to the headwaters and the South Fork Boise River to Anderson Ranch Dam. The Anderson Ranch Core Area includes the South Fork Boise River upstream from Anderson Ranch Dam to the headwaters. Lucky Peak Core Area includes Lucky Peak Reservoir and the Mores Creek watershed.

Reclamation reservoirs in southern Idaho that are known to have bull trout associated with them are Arrowrock Reservoir (mainstem Boise River), Anderson Ranch Reservoir (South Fork Boise River), Lucky Peak Reservoir (mainstem Boise River), and Deadwood Reservoir (Deadwood River in the Payette River basin). One bull trout was reported in Lake Cascade in 2004 (Esch 2004). The USFWS identifies these reservoirs and watersheds for bull trout recovery because they support essential bull trout habitat elements; provide the best available habitat with the best opportunity to be restored to high quality; provide for replication of strong subpopulations within its boundaries; are large enough to incorporate genetic and phenotypic diversity; are small enough to ensure that the component populations effectively connect; and are distributed throughout the historical range of the species in Idaho (USFWS 2002).

Most of the data used for bull trout recovery and population assessments to date come from recently collected information using electrofishing and snorkeling techniques.

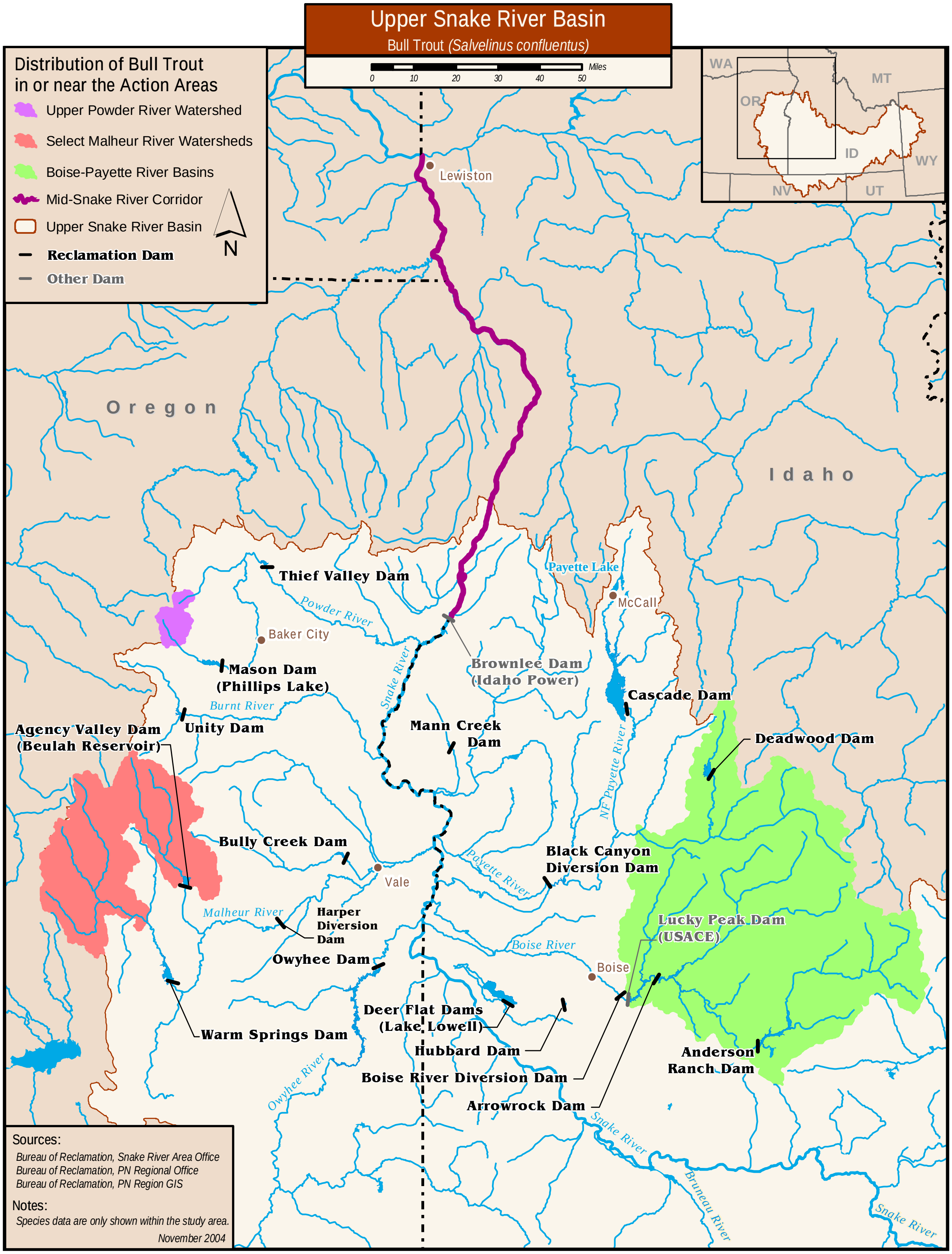

Figure 6-1. Known bull trout distributions in the watersheds associated with Reclamation facilities in the upper Snake River basin.

Comprehensive long-term monitoring data for bull trout populations do not exist for the Southwest Idaho Recovery Unit (USFWS 2002). Bull trout have been documented in the numerous tributaries, mainstem rivers, and reservoirs within the Payette and Boise River systems (Corley 1997; Dunham and Rieman 1999; Flatter 2000; Partridge 2000; Rieman and McIntyre 1995; Salow 2001, 2003, 2004b; Salow and Cross 2003; Salow and Hostettler 2004; Zurstadt and Jimenez unpublished), but their distribution is somewhat more restricted in the Payette River system (BNF 2003).

Boise River Recovery Subunit

Arrowrock and Lucky Peak Reservoirs and the North and Middle Forks of the Boise River and Mores Creek – Arrowrock Reservoir constitutes an important overwintering and foraging area for a relatively strong population of migratory bull trout. Subadults and adults migrate into Arrowrock Reservoir from upstream tributaries of the North and Middle Forks of the Boise River. The reservoir serves as important bull trout habitat from October through late spring and early summer, with a small number of fish that remain in the reservoir and mainstem South Fork Boise River downstream from Anderson Ranch Dam over the entire summer (Salow and Hostettler 2004). Many of these fish migrate out of Arrowrock Reservoir and into upstream riverine areas from February through June where they find cooler water temperatures and available spawning habitat. This migratory component is very important to the overall health and long-term persistence and recovery of this fish species as they allow for re-establishment of populations in reaches where bull trout have been extirpated (Rieman and McIntyre 1993; Whiteley et al. 2003).

The Boise River basin has been surveyed extensively for bull trout. The Boise National Forest and Reclamation conducted habitat and abundance surveys for bull trout throughout the Mores Creek, Middle Fork, and North Fork Boise River watersheds from 1999 through 2003 (Salow and Cross 2003; Salow 2004d). Greatest densities of bull trout were found in headwater streams of the North Fork Boise River including McLeod, McPhearson, Ballentyne, and Big Silver Creeks and upper Crooked River (see Figure 6-2). Bull trout were found in high numbers in the Middle Fork Boise River, the Queens and Little Queens Rivers, and Black Warrior and Decker Creeks (see Figure 6-3). A small population of bull trout was found in 2000 and 2001 in Mores Creek (a tributary to Lucky Peak Reservoir). Subsequent surveys have not found these fish (USBR unpublished). Entrainment occurs at Arrowrock Dam releasing fish into Lucky Peak Reservoir. Bull trout have been captured in gill net efforts in Lucky Peak Reservoir under a trap and transport program, which was initiated in year 2000 (Salow 2002). Analysis of population structure through use of microsatellite loci found no evidence that bull trout rearing in Mores Creek were a distinct population segment (Whitely et al. 2003). These fish were likely offspring of bull trout entrained through Arrowrock Dam that use the Mores Creek area for spawning and rearing habitat.

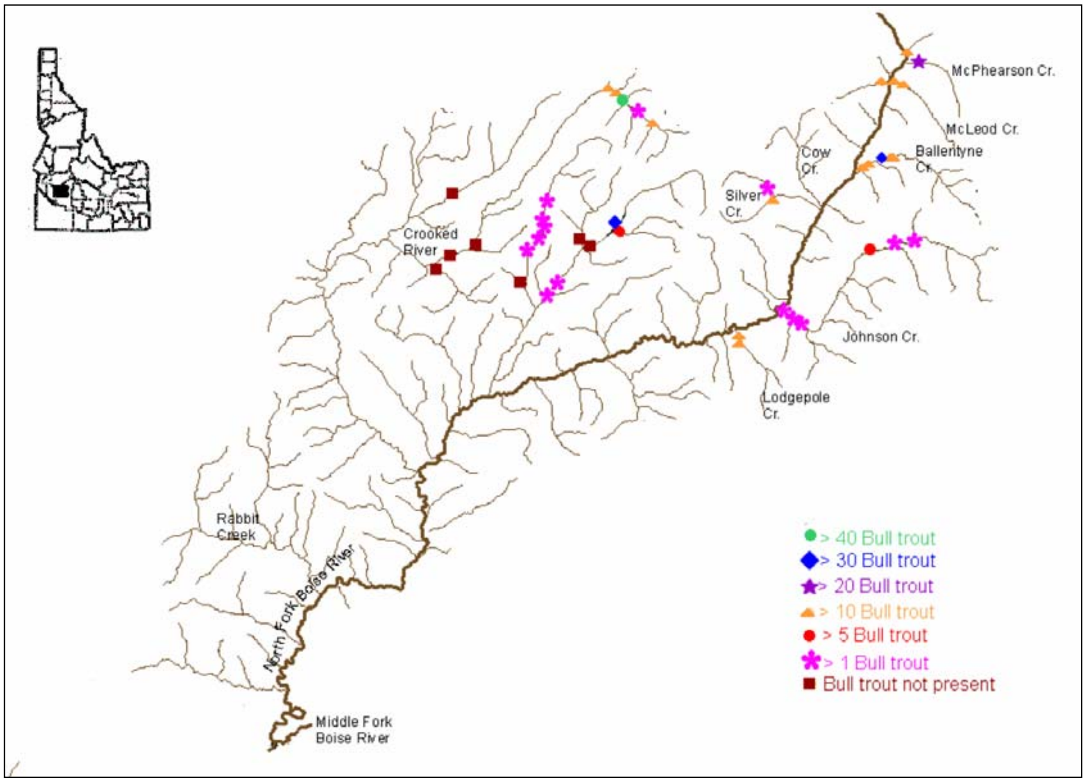

Figure 6-2. Distribution of bull trout within the North Fork Boise River watershed (Salow and Cross 2003).

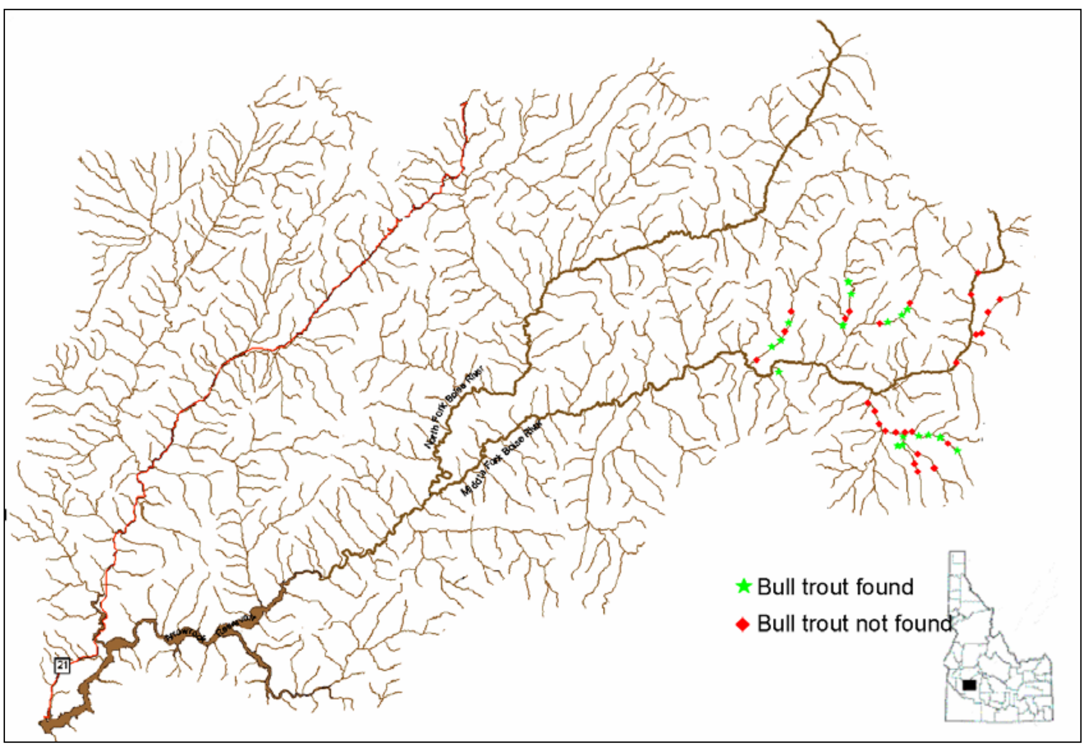

Figure 6-3. Distribution of bull trout within the Middle Fork Boise River watershed (Salow 2004d).

South Fork Boise River Downstream from Anderson Ranch Dam – To assess the health and abundance of the South Fork Boise River fishery downstream from Anderson Ranch Dam, the IDFG conducted electrofishing surveys during the fall in 1993, 1994, and 1997. Small numbers of bull trout were captured during this survey work. It is not known whether these bull trout were adfluvial (migrating up the South Fork Boise River from Arrowrock Reservoir), fluvial (residing in the South Fork), or passed through Anderson Ranch Dam; however, based on data collected in subsequent telemetry studies, it is presumed these fish originated in the North and Middle Forks of the Boise River.

Bull trout were found to use the South Fork Boise River downstream from Anderson Ranch Dam year-round as both overwintering and summer rearing habitat during radiotelemetry studies conducted in 2001 to 2003 (Salow and Hostettler 2004). Spawning within the mainstem river has not been documented, but a resident population of bull trout exists in Rattlesnake Creek, which is a tributary to the South Fork Boise River (Flatter 1999). Approximately 50 percent of the radio-tagged bull trout from the Middle and North Fork Boise Rivers enter the South Fork Boise River each fall for some period of the winter; two fish remained within the South Fork or moved between the South Fork and Arrowrock Reservoir throughout the following summer (Salow and Hostettler 2004).

Anderson Ranch Reservoir and South Fork Boise River upstream from Anderson Ranch Reservoir – Reclamation assisted IDFG in a radiotelemetry study and population estimate of bull trout at Anderson Ranch Reservoir from 1998 to 1999. The study found that Anderson Ranch Reservoir bull trout exhibited similar migratory behavior to the Arrowrock Reservoir bull trout, leaving the reservoir in late spring and spawning in the upper South Fork Boise River tributaries (Partridge 2000). The estimate of bull trout numbers in Anderson Ranch Reservoir from 1999 to 2000 was 370 individuals, with a range in length from 215 to 737 millimeters (mm) (Partridge 2000).

In 2002, backpack electrofishing was used by Fairfield Ranger District to sample for the presence of bull trout in some of the substantial perennial tributaries of the South Fork Boise River. Thirty-nine sites were sampled, with only one bull trout collected in these surveys (215 mm in length from Shake Creek).

Densities and distribution within the eastern section of the South Fork Boise River drainage has been conducted by Fairfield Ranger District. A total of 283 bull trout were sampled in the Boardman Creek drainage, while 93 bull trout were sampled in the Skeleton Creek drainage. More than 70 percent of the bull trout sampled in these drainages were shorter than 150 mm in length, and less than 5 percent were greater than 200 mm in length. Using multiple pass depletion methods for population estimation, population size was interpolated and expanded to the unsampled reaches of the monitored streams. A total bull trout population in excess of 6,200 (about 1,600 greater than 150 mm in length) was calculated in the Boardman Creek drainage prior to 2002 spawning. The comparable estimate for the Skeleton Creek drainage is about 2,200 (about 700 greater than 150 mm in length).

Weirs with trap boxes operated from late August through late October captured 85 outmigrating bull trout at the Boardman Creek weir and 69 outmigrating bull trout at the two Skeleton Creek weirs. Nearly all bull trout trapped were traveling downstream. Only one of the bull trout captured at the weirs was less than 150 mm in length, but only 9 were greater than 300 mm total length. For the three weir sites combined, 77 percent of the downstream migrants were from 175 to 249 mm in length (Kenney 2003).

Spawning and rearing populations of bull trout have been documented in the headwater streams above Anderson Ranch Reservoir. Tributaries throughout the North Fork and Middle Fork Boise Rivers and the South Fork Boise River upstream from Anderson Ranch Dam were surveyed in 2001 to analyze habitat and determine abundance and genetic structure of bull trout. Bull trout were found to be genetically different from the remainder of the Boise River basin in the South Fork Boise River upstream from Skeleton Creek. Two hypotheses may explain this difference: the foundation population for this group of fish originated in the Salmon River watershed and was colonized at a different time, or the Upper South Fork (Big Smoky Creek watershed) may have been isolated from the remainder of the system for some time prior to the construction of Anderson Ranch Dam by landslides similar to what has been documented in the Salmon River through geologic time (Whiteley et al. 2003). Skeleton Creek fish (upstream from Anderson Ranch Dam) had alleles found in North and Middle Fork populations but were not closely related in genetic distance.

Payette River Recovery Subunit

The Upper South Fork Payette River Core Area includes the Deadwood River downstream from Deadwood Dam and the South Fork Payette River. The Deadwood River Core Area includes the Deadwood River upstream from Deadwood Dam. The North Fork Payette River Core Area includes the Kennally Creek and Gold Fork Creek potential local populations. Although private diversions isolate these populations, bull trout could potentially use Lake Cascade as overwintering habitat.

Deadwood River and Reservoir – Reclamation and the USFS have recently used multiple-pass electrofishing and stream habitat surveys to identify populations of bull trout in several tributaries throughout the Deadwood River basin (see

Figure 6-4). Most populations are composed of small bull trout that appear to be resident. Although bull trout larger than 300 mm total length have been encountered in the mainstem Deadwood River and within the mouths of tributary streams, they appear to be extremely rare in the headwaters (Salow 2004b).

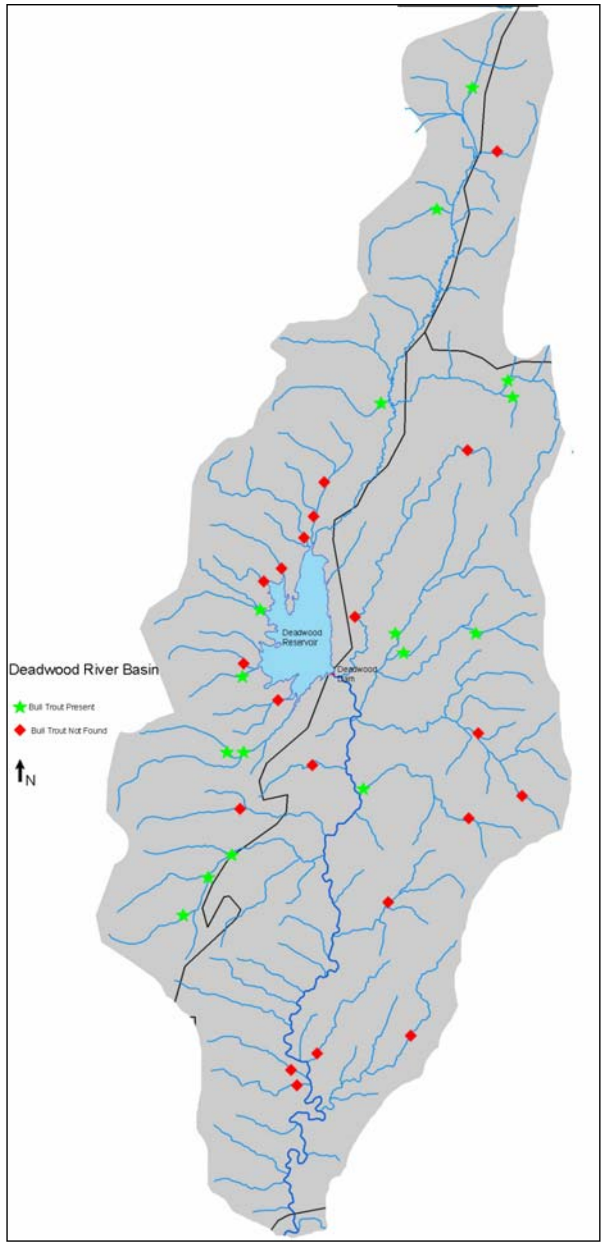

Figure 6-4. Bull trout distribution from multiple-pass electrofishing surveys in 2003 in the Deadwood River basin (Salow 2004b).

The adfluvial population of bull trout that uses Deadwood Reservoir appears to have significantly low densities relative to historical conditions. Small numbers of bull trout greater than 300 mm in total length were sampled in gill net surveys of Deadwood Reservoir. In 1997, the IDFG initiated bull trout studies at Deadwood Reservoir to determine the distribution and abundance of the adfluvial bull trout. Results from this study showed that bull trout were extremely difficult to capture. Only ten fish were caught in trap and gill nets and four were fitted with radio transmitters. Due to the small sample size, no conclusions could be made on the size, condition, or movement of bull trout in Deadwood Reservoir and its tributaries (Allen 1998).

Limited data exist to document distribution of fluvial bull trout within the Deadwood River downstream from Deadwood Dam (Allen 1998). The IDFG conducted survey work in the summer of 1998 in the Deadwood River downstream from Deadwood Dam to better determine the presence of bull trout and the condition of the habitat in that stream reach between the dam and the South Fork Payette River. The IDFG found no bull trout during this survey (Allen 1998). Large bull trout have been reported as captured by anglers immediately downstream from Deadwood Dam in

October (Kimball 2001) and in the South Fork Payette River below the confluence of the Deadwood River in June (Rieber 2003).

North Fork Payette River and Lake Cascade – One population of bull trout is known to exist in the North Fork Payette River system, in Gold Fork Creek upstream from Lake Cascade (Apperson 2002), but this population is very small, and private diversions without fish passage limit the population's access to Lake Cascade. This population is outside the action areas discussed in this assessment.

Weiser River Drainage

Several tributaries of the Weiser River have been documented to have bull trout; however, these drainages are outside of the action areas discussed in this assessment.

Malheur River Recovery Unit

The Malheur River Recovery Unit includes the mainstem and North Fork Malheur River. This unit contains one core area, the Malheur Core Area, which includes two local populations located in the headwaters of the North Fork Malheur River and Upper Malheur River subbasins, and the mainstem Malheur River from headwaters downstream to Namorf Dam, respectively.

Current distribution of bull trout includes the North Fork Malheur River (including Beulah Reservoir) and the upper Malheur River upstream from Drewsey (see Figure 6-1 on page 161). Bull trout have not been documented in Warm Springs Reservoir. In 1955, bull trout were observed as far downstream as Wolf Creek (35 miles upstream from Warm Springs Reservoir) during chemical poisoning of the Middle Fork Malheur River (Hanson et al. 1990 in Buchanan et al. 1997). Bull trout occur in several headwater tributaries and in the Malheur River as far downstream as Bluebucket Creek. Elevated stream temperatures, low streamflows and low reservoir volumes, and lack of fish passage facilities at irrigation diversions (NPCC 2002) limit bull trout in the Malheur River from Bluebucket Creek to Warm Springs Reservoir (a distance of about 45 miles); there has been no recent documentation of bull trout in this reach.

Spawning and juvenile rearing takes place in some headwater tributaries of both systems as well as in the upper mainstem North Fork Malheur River. Bull trout in the North Fork Malheur River also migrate to and overwinter in Beulah Reservoir (Schwabe et al. 2000).

Hells Canyon Complex Recovery Unit

The Hells Canyon Recovery Unit includes basins in Idaho and Oregon, draining into the Snake River and its associated reservoirs from below the confluence of the Weiser

River downstream to Hells Canyon Dam (USFWS 2002). This recovery unit includes Hells Canyon, Oxbow, and Brownlee Reservoirs on the Snake River, which are all operated by Idaho Power.

Powder River Core Area

Current distribution of bull trout in the Powder River basin is in headwater tributaries of the Powder River 8 to 17 miles upstream from Phillips Lake and 20 to 25 miles upstream from Thief Valley Reservoir in the Elkhorn Range. All bull trout inhabiting the Powder River basin are thought to be resident fish (USFWS 2002). To date, no bull trout have been documented in either Phillips Lake or Thief Valley Reservoir (Buchanan et al. 1997; USFWS 2002). Historical dredge mining along most of the Powder River upstream from Phillips Lake severely degraded those reaches' habitats; this likely limits the current bull trout distribution to the headwater tributaries (USFWS 2002).

Hells Canyon Complex Reservoirs

Current distribution of bull trout in the Hells Canyon Complex is in Oxbow Reservoir, the Oxbow Bypass Reach, and Hells Canyon Reservoir (Chandler 2003). No bull trout have been documented above Brownlee Dam (Chandler 2003). Bull trout occur in several tributaries to the Hells Canyon Projects, including the Wildhorse River, Indian Creek, and Pine Creek.

Imnaha-Snake River Recovery Unit

The Snake River basin downstream from Hells Canyon Dam to the Imnaha River supports two bull trout subpopulations: Sheep Creek and Granite Creek. Both of these subpopulations are in tributaries on the Idaho side that flow directly into the Snake River. Bull trout from both of these tributaries spend part of their life history in the mainstem Snake River (USFWS 2002). Chandler (2003) identified that bull trout use the mainstem Snake River during the winter and migrate into the tributaries in the spring either for spawning or for thermal refuge.

6.3 Life History

Bull trout exhibit two distinct life history forms in the Snake River basin: migratory and resident. Migratory fish emigrate from the small headwater streams where they emerged and reared as juveniles to larger rivers (fluvial forms) or lakes (adfluvial forms). Resident fish remain in the spawning and rearing streams throughout their entire lives (Pratt 1992). Migratory bull trout may live for several years in larger rivers or lakes, and grow larger than resident forms before returning to the tributaries to spawn (Rieman and McIntyre 1993). They can live 11 years or longer and can be sexually mature after as early as 4 years of age. Growth differs little among life-history strategies during their first years of life in headwater streams, but it diverges as migratory fish move into larger and more productive waters. Resident and migratory life-history forms of fish may live together, but it is unknown if they represent a single population or separate populations. Migratory forms of bull trout appear to use much of the river basin in which they are located throughout their life cycle (see Bjornn et al. in Batt 1996; Hostettler 2003; Salow and Hostettler 2004).

Rieman and McIntyre (1993) indicate that diverse life-history strategies are important to the stability and persistence of populations of any species. Such diversity is thought to stabilize populations in highly variable environments or to re-establish segments of populations that have disappeared.

Migratory bull trout spawn between August and November. The incubation period for bull trout is long, and fry may take up to 225 days to emerge from the gravel (Fraley and Shepard 1989). Migratory bull trout usually emigrate from their rearing streams at 2 to 3 years of age when they are 150 to 200 mm in total length; however, younger fish may occasionally emigrate earlier (Elle et al. 1994). They move downstream to preferred habitats within larger rivers or lakes and find feeding sites (Hostettler 2003). After entering the river or lake, juvenile bull trout grow rapidly, often reaching over 426 mm in total length by the time they are 5 to 6 years old, depending on available food and habitat within the system (Salow 2001).

Adfluvial bull trout associated with Reclamation facilities have been documented to reside primarily in reservoirs and controlled rivers for about 6 months during the period from November to June; however, fish have been documented to spend as much as 20 months within these areas before returning to headwater streams to spawn (Salow and Hostettler 2004). They remain in spawning habitats until the first week of September when they begin the downstream migration after spawning to the mainstem river and enter reservoirs before December (Salow and Hostettler 2004). Juvenile bull trout remain in the upper watersheds for 3 to 5 years before migrating to larger streams and reservoirs (Hostettler 2003). Bull trout do, however, remain in mainstem, regulated rivers and occasionally move into reservoirs during the summer months. This migration may be in part to avoid high summertime water temperatures in some areas or insufficient water levels during drought years (Salow and Hostettler 2004).

Variation in the timing of migration and in the timing and frequency of spawning also represents diversity in life history. Bull trout may spawn each year or in alternate years (see Block et al. in Batt 1996). It is possible that four or more age-classes could comprise any spawning population, with each age-class including up to three emigration strategies for migration (Rieman and McIntyre 1993). This theory supports the idea that the multiple life-history strategies found in bull trout populations represent important diversity within populations.

6.4 Habitat Requirements

Bull trout have more specific habitat requirements than other native trout species, mainly because they require water that is especially cold with clean cobble or gravel size substrate for spawning and development of embryos and alevins. Available reservoir habitat, bank stability, winter precipitation, drought, substrate type, available cover, cold water temperature, and the presence of migration corridors consistently appear to influence bull trout distribution and abundance (see Allan et al. in Batt 1996; Dunham and Rieman 1999; Salow 2001; Salow and Cross 2003). Available refugia are important to spawning adult fish as they are prone to predation by mammals and raptors during spawning (Salow and Hostettler 2004). Eggs are extremely vulnerable to siltation problems and bedload movement during the long incubation period.

Water temperature is a critical habitat characteristic for bull trout. Temperatures above 16 °C are thought to limit bull trout distribution (Dunham et al. 2003). Optimum water temperatures for growth in fry are thought to be 13.2 °C (Selong et al. 2001). Researchers recognize water temperatures influence bull trout distribution more consistently than any other factor. However, it is unknown if all life stages are influenced by temperature or only a particular life stage.

Bull trout are described as having voracious appetites, making them vulnerable to angling injury or mortality (Post et al. 2003). Fish are considered to be the major item in the diet of large bull trout. They feed primarily along the bottom and up to mid-water levels, consuming insects and other fish species such as suckers, sculpins, minnows, and trout (Pratt 1992). Mountain whitefish and kokanee trout are two of the bull trout's preferred prey (Knowles and Gumtow 1996; Vidergar 2000).

6.5 Factors Contributing to Species Decline

The causes of this decline of bull trout are many. These include migration barriers and diversions; forest and past fisheries management practices; habitat fragmentation and degradation through grazing and road construction; poor water quality caused by development, road construction and mining; and introduction of non-native competitive species (USFWS 2002). Sections 6.5.1 through 6.5.7 describe the current threats described in the USFWS draft *Recovery Plan for Bull Trout* (2002).

6.5.1 Passage Barriers and Stream Diversions

Dams, irrigation diversions, and other waterway alterations have interrupted bull trout migration (USBR 2003a). Dams without adequate fish passage have resulted in some populations with migratory life histories switching to resident life histories. Migratory bull trout formerly linked resident bull trout to much of the species' gene pool; currently, some resident populations are isolated, vulnerable to habitat degradation, and susceptible to a loss of genetic diversity (USBR 2003a). If a barrier occurs high in a drainage, the isolated population may be too small to sustain itself.

On bull trout streams where there are irrigation diversions, at least four potential problems may affect bull trout production: irrigation diversions reduce instream flows; the water returned to streams tends to be warmer than the water diverted; sediment is added to streams; and unscreened diversions entrain migrating juvenile bull trout to conveyance systems and fields where they die (USBR 2003a). Private irrigation diversions on tributaries above Lake Cascade limit bull trout migratory corridors (Apperson 2002).

Construction of water storage structures appears to have been a significant factor in the reduction of bull trout range and distribution (USBR 2003a). From about 1908 to about 1950, dams were constructed on historical or current bull trout streams in the Boise, Payette, and Malheur River drainages. Construction and operation of dam and diversion facilities have modified streamflows, changed stream temperature regimes, blocked migration routes, entrained bull trout, and changed bull trout forage bases. Reclamation dams that may have affected bull trout migration in the past but do not currently have documented populations of bull trout include Warm Springs Dam, Mason Dam, and Thief Valley Dam.

The operation of dams often requires substantial drawdowns of the reservoir pools, especially during drought years, to accomplish the intended and authorized project purposes. Reduced reservoir volume directly affects the amount of aquatic environment for all organisms in the food web (USBR 2003a). Extreme drawdowns reduce the production of phytoplankton, zooplankton, rooted littoral vegetation, and aquatic insects. Reduction in the food base may reduce the prey available for predator species like bull trout, although some forage fish populations may be more concentrated and more readily available as prey (USBR 2003a). Extreme reductions in reservoir volume may force bull trout and other fish species into riverine habitats.

Drought results in reduced summer streamflows, increased stream temperatures, and reduced reservoir elevations. Increased water temperatures will predictably reduce spawning success and survival of bull trout (Knowles and Gumtow 1996).

6.5.2 Forest Management Practices

Fires, insects, and timber harvest require specific management to reduce the impacts to fisheries. Catastrophic fire events can drastically alter water quality, water temperature, abundance and deterioration of woody debris, bank vegetation, and streamflow characteristics. Wildfire has been documented to affect bull trout populations (Rieman et al. 1997). Salvage timber sales have a high potential to affect isolated bull trout populations.

Loss of riparian vegetation through human activity leads to increased water temperature and siltation. Instream cover is lost due to a reduction in woody debris recruitment and unstable banks that do not allow the formation of undercut banks. Most bull trout spawning strongholds are associated with unmanaged watersheds with nearly pristine streams. Road construction for timber harvest and fire control measures leads to increased siltation, channelization, and loss of habitat complexity and may have lead to declines in bull trout historically.

6.5.3 Livestock Grazing

Livestock grazing occurs on both private and federally owned areas within the Southwest Idaho, Malheur River, and Hells Canyon Complex Recovery Units. Past practices may have contributed to reduced riparian vegetation, increased siltation, and nutrient loading where animals had long-term access to streams.

6.5.4 Transportation Networks

Construction of roads and off-road vehicle use increases siltation, causes stream channelization, and reduces habitat complexity. Roads also permit human access for recreation to areas that previously may have been inaccessible or difficult to access. Boat ramps and streamside roads allow increased angler access, which can negatively affect bull trout populations through increased mortality due to angling injuries and poaching. Roads are often built or managed for fire suppression, livestock access, recreation, recreation site access, and timber harvest. These uses collectively can negatively affect bull trout and their habitat.

6.5.5 Mining

Historically, dredge mining occurred in many watersheds where bull trout are present. Suction dredge mining, though regulated, still occurs throughout much of the Boise River basin and may negatively affect feeding, migration, and overwintering habitat for bull trout.

6.5.6 Residential Development and Urbanization

Small communities (examples in the Boise River basin include Atlanta, Featherville, Pine, and Rocky Bar) request water for hydroelectric projects, irrigation, and municipal uses. Negative impacts from seepage of household chemicals and sewage into water systems may occur as communities continue to grow. Additional road construction and maintenance for access to these remote areas may negatively affect stream channels by siltation and reduction in channel complexity.

6.5.7 Fisheries Management

Brook trout were introduced to Oregon and Idaho in the early 1900s. Brook trout not only compete directly with juvenile bull trout for food but also are genetically close enough to the bull trout to permit hybridization. Brook trout hybrids reproduce, and increased mating between bull trout and brook trout resulting in hybrids reduces the potential for bull trout populations to maintain themselves. The danger is especially acute when there are few bull trout since the hybrids cannot contribute to the bull trout population.

The USFWS (2002) also describes fisheries management as a factor for decline. Transmission of disease and injury by anglers or hatchery stocking can cause declines in bull trout and their prey. Hatchery stocking may introduce whirling disease (caused by the protozoan *Myxobolis cerebralis*), which has caused declines in rainbow trout young of year and juveniles. Additionally, fishes such as smallmouth bass stocked in reservoirs may compete with adfluvial bull trout for prey and expose bull trout to incidental angler harvest or injury. When brown trout and lake trout are present in the same waters as bull trout, they may depress or replace bull trout populations through competition for prey and may also prey upon juvenile bull trout. Other introduced species that provide forage and have different habitat preferences, such as kokanee, may benefit bull trout.

Anglers formerly viewed bull trout as a “trash fish.” Because they consume juvenile salmon and other game fish, they were considered undesirable predators. Many fish and wildlife agencies mounted active campaigns to eliminate bull trout. Even after active efforts to eliminate bull trout ceased, populations continued to decline due to impacts of other human activities. The remaining populations may suffer from a loss of genetic diversity and may not be able to sustain themselves. Angling and harvest of bull trout influence the current status of this species, which may be vulnerable to over-harvest (Post et al. 2003). Although the direct, legal harvest of bull trout has been eliminated or restricted in most states, incidental take of this species in recreational trout fisheries and by poachers, especially in streams supporting large migratory fish, as well as catch and release mortality, may further affect bull trout abundance (Salow and Hostettler 2004).

Chemical treatments to control non-game fish species may have also adversely affected bull trout throughout their range. Chemical treatment of stream sections may have injured or killed adfluvial bull trout that use rivers and reservoirs for overwintering.

6.6 Recovery Efforts

In 1995, Idaho Governor Phil Batt initiated development of a conservation plan to restore bull trout populations in Idaho. The mission of the Governor's Bull Trout Conservation Plan (released July 1996) is to "…Maintain and/or restore complex interacting groups of bull trout populations throughout their native range in Idaho." The goals of this plan include:

1. Maintain the condition of those areas presently supporting critical bull trout habitat.
2. Institute recovery strategies that produce measurable improvements in the status, abundance, and habitats of bull trout. Concentrate resources and recovery efforts in areas that will produce maximum cost-effective, short-term returns and that will also contribute to long-term recovery.
3. Establish a secure, well-distributed set of sub-watersheds within key watersheds to achieve a stable or increasing population and to maintain options for future recovery.
4. Achieve the above goals while continuing to provide for the economic viability of Idaho's industries.

The 1997 "Status of Oregon's Bull Trout" (Buchanan et al. 1997) reports that 81 percent of Oregon's bull trout populations are considered to be at a "moderate risk of extinction," "high risk of extinction," or "probably extinct." This report discusses life history, habitat needs, potential limiting factors, and risks for bull trout populations on a basin-by-basin basis. The report concludes with a section on research and management needs, followed by recommendations.

After the listing of the Columbia and Klamath Distinct Population Segment (DPS) of bull trout in 1998, the USFWS released the draft *Recovery Plan for Bull Trout* (2002) and draft proposal for critical habitat designation (67 FR 71236). Both of these documents used the Oregon and Idaho bull trout plans to develop recovery goals and establish primary constituent elements for critical habitat. Recovery goals outlined in the plan are similar to those stated in the Idaho plan but are more broadly applicable to the entire Columbia DPS as it was listed. These are:

1. To maintain and restore the distribution of bull trout.
2. To maintain and restore habitat for all life history forms.

3. To conserve genetic diversity.
4. To implement recovery actions and assess their success.

Teams of Federal, State, and private individuals were created to develop and implement specific objectives for each recovery unit that was delineated in the recovery plan. Reclamation has been involved with the Southwest Idaho, Malheur, and Hells Canyon Complex Recovery Unit teams (projects located within the area covered by this consultation) and provides data and technical expertise to these teams.

In 1999, the State of Idaho initiated a public education campaign to improve angler awareness of the various resident salmonid species in several areas of Idaho. The program included brochures, stickers, large signs within drainages, and an interaction program to test angler's ability to identify the various resident salmonids. The IDFG continues to support this program through signs, brochures, and active enforcement.

Bull trout are distributed primarily on federally owned land within the action areas. Most Federal agency actions that improve conditions for bull trout are non-discretionary actions conducted in response to reasonable and prudent measures and terms and conditions developed as a part of Section 7 ESA consultations, as opposed to efforts specifically pursued to implement recovery plans.

6.7 Current Conditions in the Action Areas

The USFWS has determined that the Reclamation facilities that affect bull trout within the action areas are Arrowrock, Anderson Ranch, Deadwood, and Agency Valley Dams (USFWS 1999; 67 FR 71236). Reclamation operations that control the conveyance and storage of irrigation water in the Lucky Peak Dam and Reservoir are also considered in this consultation. Construction and operation of these facilities have modified streamflows, changed stream temperature regimes, blocked migration routes, entrained bull trout, and changed bull trout forage bases. Though little information is known about the extent of the impacts to migration of bull trout from these facilities, populations of bull trout have been found upstream, downstream, or adjacent to these facilities.

This consultation includes a discussion of bull trout in the Hells Canyon Complex area. Reclamation did not discuss the potential impacts from Reclamation operations in the upper Snake River basin to bull trout present in reaches of the mainstem Snake River between Oxbow Reservoir and Lower Granite Reservoir in previous consultations. The USFWS, in previous biological opinions, has not indicated any effects to bull trout in the lower Snake River.

6.7.1 Boise River Basin

Bull trout have been found during surveys in headwater streams of the North Fork Boise River, the Yuba, Crooked, and Queens River drainages, and Black Warrior and Mores Creeks (Salow and Cross 2003; Salow 2004d). Additionally, bull trout have been found to inhabit Arrowrock, Lucky Peak, and Anderson Ranch Reservoirs as adfluvial forms (Flatter 2000; Partridge 2000; Salow 2002).

Population structure analysis using genetic markers can help determine how closely groups are related, to determine if groups have been isolated from other groups within the same population, and as an aid to determine migratory components. Through the analysis of microsatellite loci, Whiteley et al. (2003) discuss the weak population differentiation within the Boise River basin with the exception of the South Fork Boise River (upstream from the mouth of Skeleton Creek on the South Fork Boise River). This area stands as an outlier from the remainder of the system and should be considered a separate conservation unit. The weak population differentiation seen in the Middle and North Fork Boise Rivers is most likely due to the frequent disturbance within the system (from fire, flooding, and drought). The weak population differentiation within these streams also stresses the importance of the migratory component of fish within the North and Middle Forks of the Boise River. Bull trout in the Mores Creek watershed, a tributary of Lucky Peak Reservoir, were most likely offspring of entrained bull trout that passed through Arrowrock Dam into Lucky Peak Reservoir from the North and Middle Forks of the Boise River.

Arrowrock and Lucky Peak Reservoirs and the North and Middle Forks of the Boise River

Arrowrock Reservoir constitutes an important overwintering and foraging area for a relatively strong population of migratory bull trout. Bull trout inhabiting Arrowrock Reservoir are adfluvial forms that spend several years in the tributaries (and up to 20 months in the reservoir) until they mature, generally when 5 to 7 years old. Subadults and adults migrate into Arrowrock Reservoir from upstream tributaries of the North and Middle Forks of the Boise River. The reservoir serves as important bull trout habitat from October through late spring and early summer, with a small number of fish that remain in the reservoir and mainstem South Fork Boise River downstream from Anderson Ranch Dam over the entire summer (Salow and Hostettler 2004). Many of these fish migrate out of Arrowrock Reservoir and into upstream riverine areas from February through June where they find cooler water temperatures and available spawning habitat. This migratory component is very important to the overall health and long-term persistence and recovery of this fish species as it allows for re-establishment of populations in reaches that have been extirpated. (Rieman and McIntyre 1993; Whiteley et al. 2003).

Reclamation annually begins drafting Arrowrock Reservoir (usually as part of flood control in April) to a conservation pool of 28,700 acre-feet (the reservoir may be drafted below 10,000 acre-feet in dry years) and holds at this level until Labor Day. In the past ten years, the reservoir volume has fallen below the conservation pool volume twice, during the fall of 1994 and during the fall of 2003 for construction associated with valve replacement. All storage in the reservoir, with the exception of a small volume of dead space created by retirement of the sluice gates in 2004, is usable for irrigation and flood control. The lower pool elevations in Arrowrock Reservoir are a result of Reclamation releasing water to meet irrigation demand to maintain a recreation pool in Lucky Peak Reservoir (USBR 2004b). In normal water years, Lucky Peak Reservoir is kept nearly full from Memorial Day to Labor Day to provide for recreation. However, efficiency dictates that Reclamation store water as high in the river system as possible, and this means that Arrowrock Reservoir's end-of-season volume may be more than the conservation pool, especially during years of above-average runoff. After Labor Day, Lucky Peak Reservoir provides water to meet irrigation demands while Arrowrock Reservoir begins to refill. Generally, Arrowrock Reservoir is at or near its conservation pool through July and August.

When Arrowrock Reservoir is rapidly drawn down to very low levels, some portion of nutrients, food organisms, and fish pass through the dam into Lucky Peak Reservoir; this contributes to the reduction of the self-sustaining fish resource. The rapid summer drafting of Arrowrock Reservoir for irrigation and the low winter reservoir levels likely reduce the reservoir's productivity, provide little littoral region, and consequentially discourage growth and reproduction of aquatic invertebrates and plants. This limits the production and sustenance of aquatic fauna, especially zooplantivores, such as kokanee trout (May et al. 1988), a major prey item for bull trout in other lakes and reservoirs (Vidergar 2000).

Arrowrock Reservoir conservation pool elevations and suitability of water quality conditions for adfluvial bull trout populations depend on the annual fluctuations in weather conditions and impacts of consecutive years of high or low regional stream runoff (USBR 2003b). Currently, bull trout habitat is available through most of the year except July through September in consecutive dry years when temperatures rise and dissolved oxygen levels fall below acceptable levels (USBR 2003b).

The IDFG, with funding from Reclamation, conducted a radiotelemetry and mark recapture study of bull trout at Arrowrock Reservoir from 1996 to 1998 (Flatter 2000). The purpose of the study was to estimate the population size, document entrainment from Arrowrock Reservoir into Lucky Peak Reservoir, and delineate some life history characteristics. Flatter found an estimated 471 bull trout for 1997 and an estimated 345 bull trout for 1998 that were 300 mm or longer. Estimated entrainment rates for bull trout equal to or greater than 300 mm in total length were 42 bull trout for 1997 and 54 bull trout for 1998.

High entrainment rates could be attributed to large flood control releases in the winter, such as those made during the 1997 and 1998 water years. During the period that adfluvial bull trout were overwintering in Arrowrock Reservoir, the reservoir content was dropped from 252,960 acre-feet on December 31, 1996, to 62,120 acre-feet on March 31, 1997. Arrowrock Reservoir was then filled quite rapidly through the end of June.

Flatter (2000) also investigated migration and movement patterns. Adult bull trout were found to migrate from Arrowrock Reservoir into the Middle Fork and North Fork Boise Rivers from May to June and spawn in the upper tributaries in August and September. Not all adult fish migrate in a given year, and mature adfluvial bull trout appear to reside in the reservoir for about 6 months, from November to June. Bull trout will occupy deeper areas of the reservoir where water temperatures are cooler (7 to 12 °C) and move to the surface when surface water temperatures drop to or below 12 °C.

The IDFG also determined whether fish were entrained through the ensign valves or over the spillway of Arrowrock Dam and at approximately what the depth at which the fish were entrained. Flatter (1999) found that of the radio-tagged bull trout entrained through Arrowrock Dam in 1998, four of ten were entrained through the valves, with depths from the surface to the upper valves ranging from 19 to 111 feet when those fish were entrained. Flatter (1999) also found that 6 of 10 bull trout were entrained over the spillway during the same period.

Reclamation conducted work similar to Flatter to determine the extent of entrainment related to the Arrowrock Dam valve rehabilitation project. This work was initiated in 2001 and extended through 2004 to determine entrainment rates before, during, and after the construction project. Because the spillway was not operated during the period of the construction project, all of the bull trout that were entrained did so through the valves. The overall rate of entrainment observed during the construction project was comparable to that observed in Flatter's work (just over 11 percent compared to 10 to 16 percent). The depths from the reservoir surface at which the fish were entrained during the construction project (15 to 105 feet) were similar to the range found by Flatter. Entrainment occurred primarily at higher than average discharge from the dam near the surface elevation of the reservoir (Salow and Hostettler 2004).

Reclamation altered operations of Arrowrock Dam in 1999 to reduce use of the spillway. Reclamation documented 6 of 118 radio-tagged bull trout entrained in 2002 (5.09 percent, prior to the reservoir draw down for construction) and 6 of 53 radio-tagged bull trout entrained in 2003 (11.3 percent during the construction related draw down). If extrapolated to population level of fish greater than 300 mm, the entrainment estimate would be 24 for 2002 and 69 for 2003 (Salow and Hostettler 2004).

Based on limited data from the Arrowrock Reservoir bull trout investigations, it appears that bull trout moved into Lucky Peak Reservoir over a wide range of Arrowrock Reservoir elevations. Rates of entrainment appear to be positively correlated with high velocity discharge (either over the spillway or through the gates) that occurs near the reservoir surface (Salow and Hostettler 2004).

Beginning in 2000, Reclamation initiated a trap and haul program for the bull trout entrained into Lucky Peak Reservoir, returning them to Arrowrock Reservoir as part of the USFWS terms and conditions identified in their biological opinion for Arrowrock Dam construction activities (USFWS 2001). This trap and haul program will continue until a long-term entrainment reduction solution is determined. Since the implementation of the program, over 60 bull trout have been trapped and returned to Arrowrock Reservoir (Salow 2002).

Rehabilitation of the lower row of valves at Arrowrock Dam began in September 2001 and was completed in 2004. Valve replacement required short-term changes in reservoir operations at Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs. Construction activities have occurred mostly during the non-irrigation season (September through February). Drafting of Arrowrock Reservoir was necessary during the winter of 2003-2004 to allow for work on the upstream side of Arrowrock Dam. Some sediment was released from Arrowrock Dam during the third season of construction, which was complicated by a large wildfire and subsequent landslides on the Middle Fork Boise River (Hot Creek Fire in July 2003). The sluice gates were not operated to pass elevated inflows at any time during the construction project.

Reclamation initiated a large-scale radiotelemetry investigation to monitor the impacts of the reservoir drawdown on the adfluvial population of bull trout in 2001. Major components of this work included documenting mortality rates and associated causes of mortality, reservoir use and timing, and levels of entrainment for adfluvial bull trout using Arrowrock Reservoir. Monthly updates and an interim report with findings to date are available (Salow 2003, 2004a; Salow and Hostettler 2004).

Significant findings to date from this investigation showed that little mortality related to water quality was observed. Mortality rates increased when Arrowrock Reservoir was reduced to a 1,500-acre-foot pool during a replacement of valves on the dam in 2003. The reservoir dewatering and the subsequent channelization of normally inundated areas created unstable stream banks; there was no other cover for fish available, and these banks collapsed frequently. The migratory corridor near Irish Creek provided water depth and channel stability when the reservoir area was inundated to an elevation of 944.9 m (3,100 feet; 38,840-acre-foot volume) (Salow 2004d).

The valve replacement construction project more than doubled mortality rates for post-spawning bull trout. Prior to construction, 22 percent of tagged fish were killed during the post-spawning migration. During the construction project, 47 percent of radio-tagged fish were killed during this time frame. Most mortality was due to increased predation related to poor habitat conditions; no refugia habitat (areas to hide) was available in migratory corridors within the upper reservoir. Estimated numbers of bull trout killed during the construction project (using the 2002 estimate from Table 6-3) would be 157 fish from the North Fork Boise River population and 113 fish from the Middle Fork Boise River population. Impacts to bull trout due to degraded water quality conditions were not found, though it had been anticipated as the primary cause of mortality during the planning process (Salow and Hostettler 2004).

Reclamation and the IDFG have documented bull trout mortality from angling or poaching. Reclamation has worked closely with IDFG staff to fund public signs warning anglers to release bull trout. Additionally, Reclamation works closely with IDFG enforcement staff to document important holding areas for bull trout with public access where poaching is likely. Poaching and angling-related mortality still occur despite informational signs and brochures distributed to anglers (Haynes 2003).

Hybridization between introduced brook trout and bull trout has been documented in several tributary streams in the Boise River basin. Hybridization has been documented in the Crooked River and its tributaries that flow into the North Fork Boise River (Whiteley et al. 2003).

Weir count data is being used to generate population estimates for adult adfluvial bull trout that overwinter in Arrowrock Reservoir and the South Fork Boise River below Anderson Ranch Dam. Reclamation operates weir traps on the North Fork and Middle Fork Boise Rivers to capture post-spawning adult bull trout and juvenile migrants returning to Arrowrock Reservoir. The North Fork Boise River weir was first operated in 1999, and the Middle Fork Boise River weir was first operated in 2002. Continued operation of both weirs has occurred in conjunction with the valve replacement work and will continue through 2005 to monitor the bull trout population. The data are revealing a declining trend in overall population size for the Boise River adult adfluvial population of bull trout (see Table 6-3). Salow (2004c) more completely describes the analyses and biases using weir counts for annual population estimates.

Table 6-3. North Fork Boise River weir trap mark-recapture population estimates (Salow 2004c).

Year	Marked Year 1	Marked Year 2	Recaptured Year 2	Estimate	Standard Deviation
1999	109	121	18	732.72	159.34
2000	143	113	28	577.11	94.59
2001	157	68	23	464.17	78.74
2002	102	49	15	333.20	71.66

Surveys conducted over multiple years found that reduced water levels (winter precipitation and spring runoff) were negatively correlated with reduced fish densities in small, high-elevation tributary streams (Salow and Cross 2003). Additionally, drought appears to have significant negative effects on survival of bull trout, especially with juvenile bull trout migrating within the main river (based on the composition and overall catch rates of juvenile bull trout at weirs in Salow 2004c).

Several other investigations into aspects of bull trout life history are ongoing within the Boise River basin. Reclamation, the Boise National Forest, the IDFG, and Boise State University are cooperating in conducting two radio-tagging and tracking investigations for juvenile and subadult-sized (less than 300 mm in total length) bull trout. The first examines movements, overwintering behavior, and migration patterns in the North Fork Boise River and Arrowrock Reservoir. This project is a 2-year graduate program through Boise State University and is scheduled to be completed in December 2004. Work completed so far indicates that distance of downstream movement in juvenile bull trout is positively correlated to the total length of the fish and that decreases in temperature and increases in flow affect timing of downstream movement (Hostettler 2003). The second study will examine reservoir habitat use, duration of occupancy, and feeding patterns by bull trout. This 2-year study is anticipated to be completed in June 2006.

South Fork Boise River Downstream from Anderson Ranch Dam

To assess the health and abundance of the South Fork Boise River fishery downstream from Anderson Ranch Dam, the IDFG conducted electrofishing surveys during the fall in 1993, 1994, and 1997. Small numbers of bull trout were captured during this survey work. It is not known whether these bull trout were adfluvial (migrating up the South Fork Boise River from Arrowrock Reservoir), fluvial (residing in the South Fork), or passed through Anderson Ranch Dam; however, based on data collected in subsequent telemetry studies, it is presumed these fish originated in the North and Middle Forks of the Boise River.

Radiotelemetry studies conducted from 2001 to 2003 (Salow and Hostettler 2004) showed bull trout using the South Fork Boise River downstream from Anderson Ranch Dam year-round as both overwintering and summer rearing habitat. Spawning within the mainstem river has not been documented, but a resident population of bull trout exists in Rattlesnake Creek, a tributary to the South Fork Boise River (Flatter 1999). Approximately 50 percent of the radio-tagged bull trout from the Middle and North Fork Boise Rivers enter the South Fork Boise River each fall for some period of the winter; two fish remained within the South Fork or moved between the South Fork and Arrowrock Reservoir throughout the following summer (Salow and Hostettler 2004).

Water temperatures recorded downstream from Anderson Ranch Dam (10 to 12 °C) are suitable for adult bull trout occupancy during most of June through October, but the temperatures have lacked the normal stream variation and the natural flow regime of free-flowing streams. Releases from the dam have occurred by passing water through the intake located deep in the reservoir's water column. Generally, mean daily water temperatures below the dam in normal water years have ranged from 3.7 to 11.4 °C. In years where powerhead has been used to supply streamflows (usually consecutive dry years), mean daily water temperatures can get as high as 15.3 °C.

The South Fork Boise River is a regulated stream with a discharge required to meet a variety of needs, including minimum streamflows, power generation, and irrigation demands. Under past and current operations, the lack of a natural hydrograph has altered and possibly reduced channel complexity; altered streamflow (including daily mean flow, peak variation, and timing); altered water temperature mean and natural variation; altered the aquatic community composition; and altered the migratory corridor condition. Streamflow alteration has been found in other impounded systems to affect aquatic fauna and can completely change an aquatic community (Mueller and Marsh 2002; Marotz et al. 1999). The flow regime identified in USBR (2004b) has likely affected the downstream fishery, but the magnitude and extent of the effect has not been studied and is currently unknown.

Maintenance operations at Anderson Ranch Dam that require dewatering the penstock and releasing water over the spillway after May 15 (such as occurred in 2003) cause temperature increases, which may adversely affect bull trout summer habitat and migration patterns. Reclamation has informally consulted on individual maintenance activities that required penstock dewatering. The unique aspects of each maintenance activity may require alteration of seasonal timing, volume, and release elevation. Informal consultations will continue individually for each maintenance activity.

Anderson Ranch Reservoir

Reclamation assisted the IDFG in a radiotelemetry study and population estimate of bull trout at Anderson Ranch Reservoir from 1998 to 1999. The study found that Anderson Ranch Reservoir bull trout exhibited similar migratory behavior to the Arrowrock Reservoir bull trout, leaving the reservoir in late spring and spawning in the upper South Fork Boise River tributaries (Partridge 2000). One notable contrast between Arrowrock Reservoir and Anderson Ranch Reservoir is that the Anderson Ranch study did not document fish entrainment through Anderson Ranch Dam. This lack of entrainment may be due to releases made from a greater depth and infrequent surface spills that occur later in the year.

Reclamation and the IDFG participated in a second radiotelemetry study in the spring of 2002 using temperature-depth archival tags in conjunction with radio tags to examine overwintering reservoir habitat use, movement, and entrainment. No entrainment was documented in this study. Unfortunately, the temperature-depth tags did not remain attached to these fish, and therefore, data could not be collected.

Water quality conditions for adfluvial bull trout populations have depended on the annual fluctuations in weather conditions such as wind and precipitation as well as impacts of consecutive years of high or low regional water levels. Anderson Ranch Reservoir's significant conservation pool (due primarily to the design and operation of the dam) appears to provide adequate water for bull trout (USBR 2004a). The volume of 62,000 acre-feet in the conservation pool is a combination of inactive storage and water held to maintain hydraulic pressure (often referred to as 'power head') to generate power. Under past operations, temperature and dissolved oxygen elements generally met State of Idaho standards for salmonid rearing and suitable thermal habitat (between 2 and 15 °C) through most of the year. However, conditions have become marginal in mid- to late summer, especially in consecutive dry years (USBR 2004a).

Fish kills, primarily of kokanee trout, were observed in August 2001, a drought year. That year, spring runoff was not sufficient to fill Anderson Ranch Reservoir. The effect of multiple years of drought that preceded 2001 led to low water volumes; an anoxic section of water moved through the reservoir and presumably caused the fish kills (Megargle 2004). As Figure 6-5 shows, Anderson Ranch Reservoir water elevations had not reached such low levels since 1993 and 1994; however, no fish

Figure 6-5. Anderson Ranch Forebay elevations, 1990 through 2003.

kills were documented during those years. The anoxic zone of water was presumably caused by the combined factors of the reduced cross winds that would normally allow for surface currents and turnover, high water temperatures caused by unusually high air temperatures, and unusually low water volumes (see Figure 6-5, Figure 6-6, and Figure 6-7). Kokanee trout have been documented in numerous studies as an important prey item for bull trout (Vidergar 2000; Beauchamp and Van Tassell 2001); however, the loss of kokanee trout as a source of prey that occurred in 2001 has had an unknown effect on Anderson Ranch bull trout.

6.7.2 Payette River Basin

Deadwood River and Deadwood Reservoir

Adequate water temperatures and the presence of adequate water volume have been available for bull trout except in consecutive dry years. Deadwood Reservoir has a conservation pool held at 50,000 acre-feet. Under past operations, temperature and dissolved oxygen levels generally met State of Idaho standards for salmonid rearing and suitable thermal habitat (between 2 and 15 °C) through most of the year. However, conditions have become marginal in mid- to late summer, especially in consecutive dry years (USBR 2004c).

Generally, the food base for bull trout has been abundant in Deadwood Reservoir under past and current operations. Kokanee trout and cutthroat trout, both introduced species, are generally abundant, and their densities have fluctuated over time, depending on spawning success. The IDFG operates a weir to capture and monitor upstream movement of kokanee in the fall of each year. Kokanee serve as an important prey item for bull trout in lakes and reservoirs where both species are present (Vidergar 2000).

Anglers have reported poor catch rates for bull trout in Deadwood Reservoir since 1990 (Salow unpublished, Deadwood Reservoir). Few adfluvial bull trout have been documented in Deadwood Reservoir since 1997 (Allen 1998). Chemical treatment of stream sections to remove undesirable fishes in the Deadwood River basin upstream from Deadwood Dam in 1992 may have injured or killed adfluvial bull trout using Deadwood Reservoir for overwintering (Jimenez and Zaroban 1998). The decline in numbers of adfluvial bull trout found in Deadwood Reservoir corresponds to reduced kokanee populations and low reservoir volumes that occurred in the late 1980s and early 1990s. In addition, Atlantic salmon (a competitor with bull trout for prey) were introduced to Deadwood Reservoir in the early 1990s.

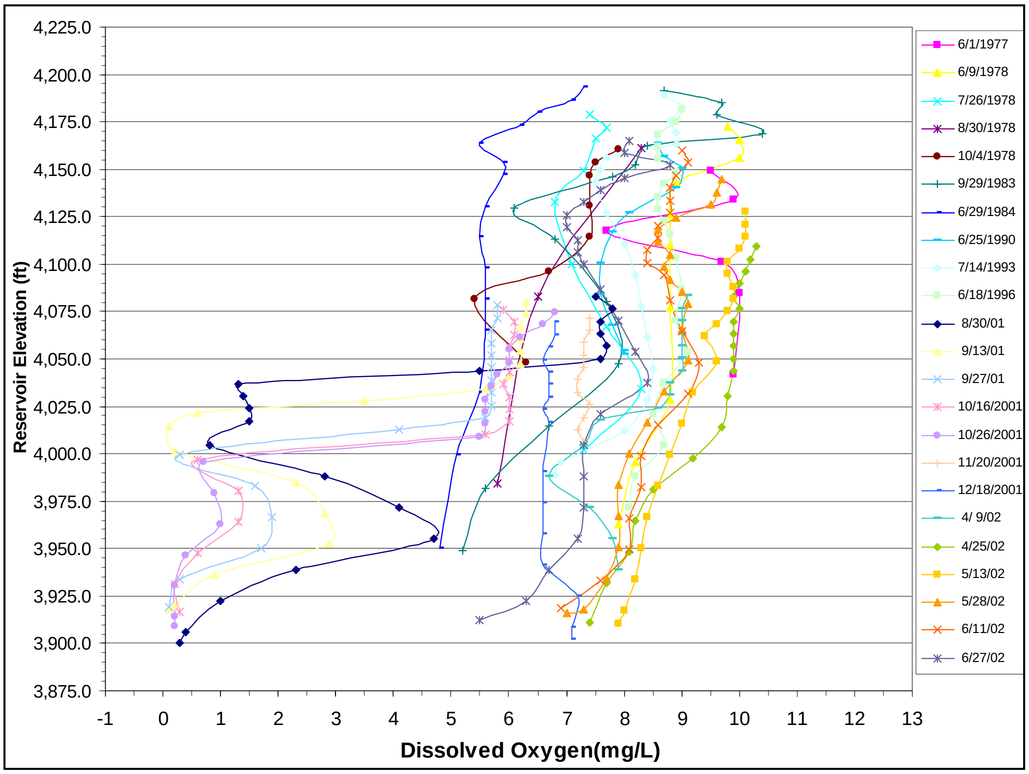

Figure 6-6. Dissolved oxygen reservoir profiles 100 meters in front of Anderson Ranch Dam through a series of years.

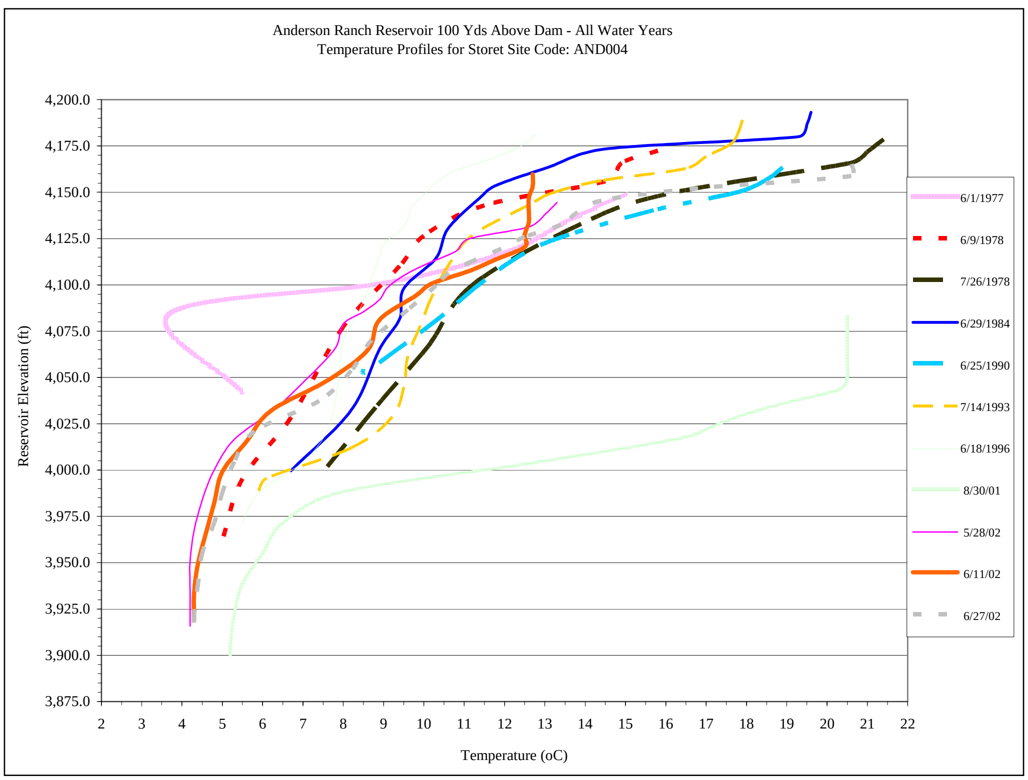

Figure 6-7. Water temperature reservoir profiles 100 meters in front of Anderson Ranch Dam through a series of years.

Since 1996, the Lowman Ranger District of the Boise National Forest has been investigating the relationship between habitat characteristics and resident bull trout abundance in an effort to identify the quality and amount of available resident bull trout habitat within the Deadwood River drainage. This work indicates that stream reaches having large woody debris and higher numbers of plunge and dam pools tend to have higher bull trout densities (Zurstadt and Jimenez unpublished).

The presence of a fluvial bull trout population in the Deadwood River downstream from the dam remains speculative. Similar to the South Fork Boise River below Anderson Ranch Dam, the Deadwood River downstream from the dam may function as an important migratory corridor and summer rearing habitat for bull trout. Unlike bull trout in the South Fork Boise River, most evidence of the presence of bull trout within the mainstem river downstream from Deadwood Dam has been anecdotal. Water temperature downstream from the dam under past and current operations has been substantially colder and has lacked the variability of other unregulated streams within the same areas of Idaho. The change in thermal and flow regimes has most likely altered the aquatic community and has accounted for the paucity of fish and macroinvertebrate fauna observed (Allen 1998; Salow unpublished, Deadwood Reservoir).

Water normally flows over the unregulated spillway at Deadwood Dam in the month of June. If there is a population, historical Deadwood Reservoir releases may have had an adverse effect. Historically, reservoir surface water spilled in June had a temperature of up to 21 °C. Water released through the outlet valves had a temperature as low as 7 °C.

In 1997, Reclamation began releasing water from the outlet valves as water spilled to reduce the extreme difference in water temperature downstream from the dam. This provided summertime water temperatures from 7 to 10 °C below the dam and from 12 to 15 °C near the mouth of the Deadwood River. Although the mixed release regimen increased June and July water temperatures of 7.2 to 10 °C below the dam in the Deadwood River, dry years provided no spill and water temperatures remained very cold. Figure 6-8 shows this interaction in the past several years.

Mixed spill provides a temporary increase in temperatures during the time the reservoir is full; however, in many years, the water temperatures are still much colder and less variable in comparison to watersheds of similar size and elevation within the basin (see Figure 6-9).

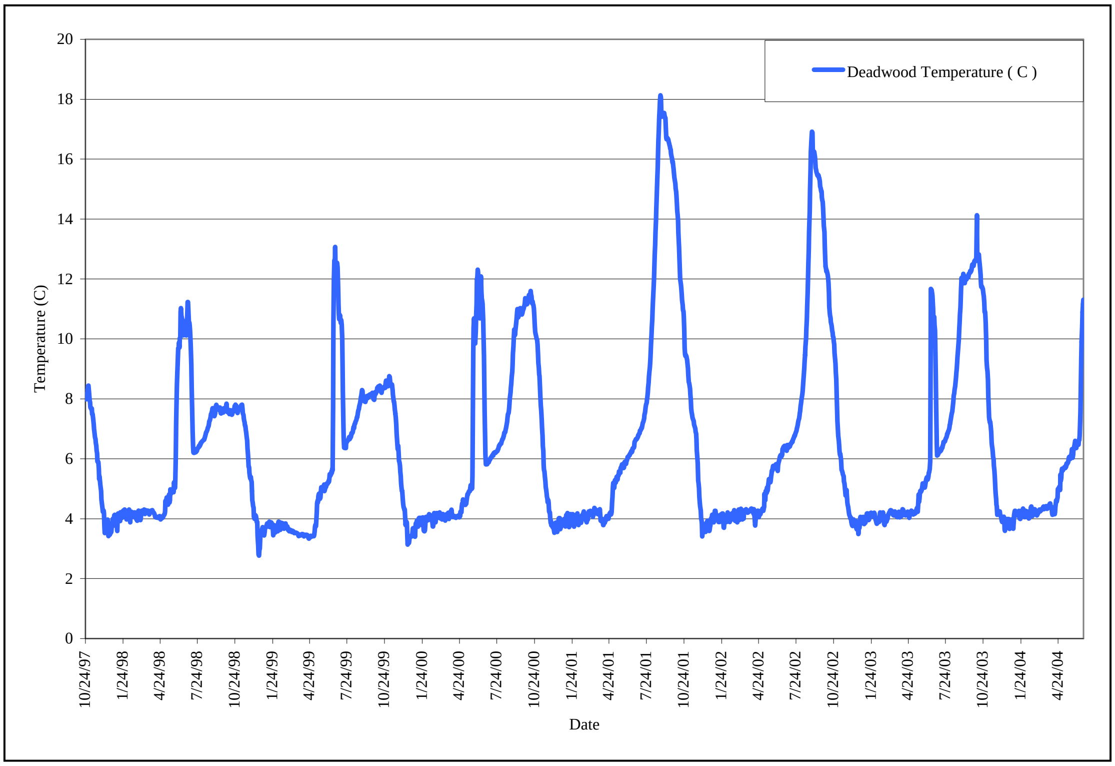

Figure 6-8. Water temperatures in the Deadwood River downstream from Deadwood Dam.

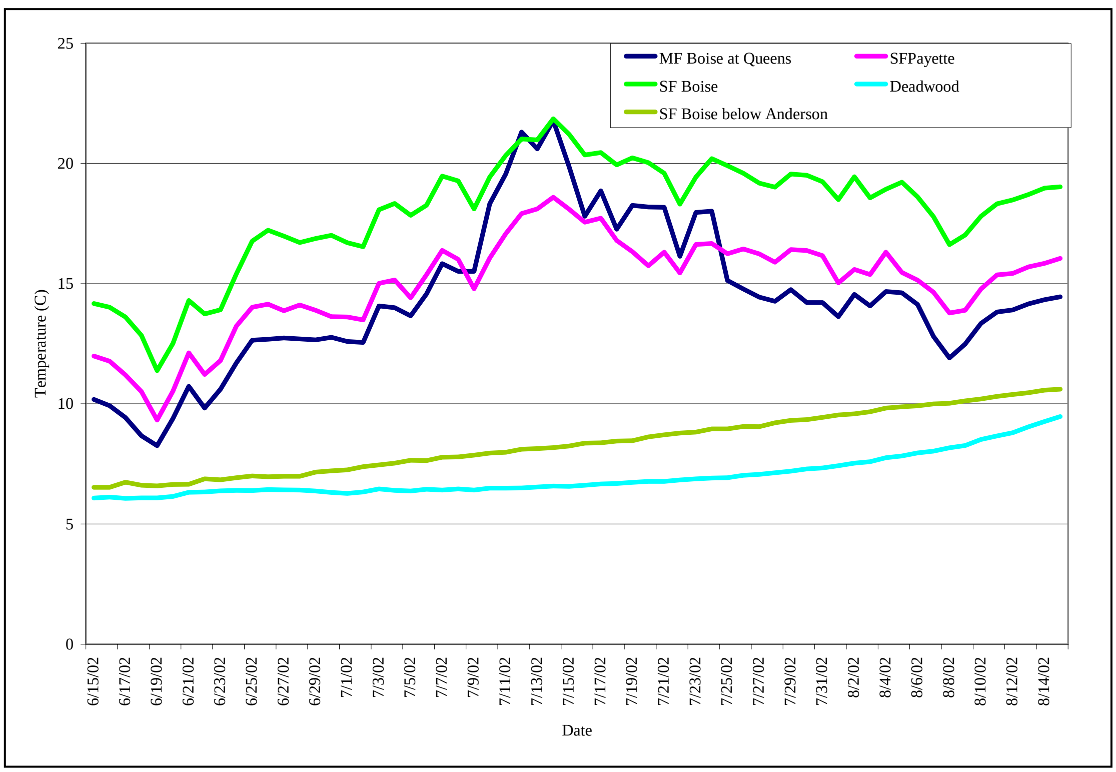

Figure 6-9. Comparison of daily mean stream temperatures in mainstem rivers in the Boise and Payette River drainages.

Under past and current operations, the lack of a natural hydrograph has altered and possibly reduced channel complexity; altered streamflow (including daily mean flow, peak variation, and timing); altered water temperature mean and natural variation; altered the aquatic community composition; and altered the migratory corridor condition. Streamflow alteration has been found in other impounded systems to affect aquatic fauna and can completely change an aquatic community (Mueller and Marsh 2002; Marotz et al. 1999).The flow regime has likely affected the downstream fishery, but the magnitude and extent of the influence has not been studied and is currently unknown.

Reclamation has informally consulted on individual maintenance activities that have occasionally required dewatering of the Deadwood Dam outlet works. Dewatering the outlet works affects the river reach about 650 feet downstream to the mouth of Wilson Creek. The unique aspects of each project may require alteration of seasonal timing, volume, and release elevation. These consultations will continue individually for each project.

Lake Cascade

One bull trout was reported in Lake Cascade in 2004 (Esch 2004). This fish was relatively small (less than 300 mm in total length) and was reported by a former USFWS employee but not photographed. The fish is most likely a fish from the Gold Fork local or the Kennally Creek potential population, which was surveyed extensively in 2002 with only one fish found (Apperson 2002). Because there are no fish passage facilities at the private irrigation diversions on Gold Fork Creek upstream from Lake Cascade, and because the migratory corridor is severely limited during the irrigation season when diversions completely dewater areas of the creek, the fish presumably moved out of the creek in late fall after irrigation diversions were shut down (Apperson 2002).

Although Lake Cascade provides adequate overwintering habitat for bull trout, it is unlikely that bull trout will survive high water temperatures in the lake over the summer (the shallow depth and great width of the lake generally lead to these higher temperatures). Lake Cascade's high levels of nutrients, algal biomass, and decaying benthic layer make the lake eutrophic (USBR 1997a), which may be exacerbated by the low rate of residence time (movement of water through the lake). The lake usually has high surface water temperatures and low dissolved oxygen levels in the summer and early fall months that can kill fish and other aquatic fauna (USBR 1997a).

6.7.3 Malheur River Basin

Bull trout are found in Beulah Reservoir, the North Fork Malheur River upstream from Beulah Reservoir, and the mainstem Malheur River about 45 miles upstream from Warm Springs Reservoir. Reclamation, the Burns Paiute Tribe, the ODFW, the USFWS, and the USFS have monitored headwater streams in the Malheur River for the presence of bull trout and found them in several tributaries to the mainstem rivers. Bull trout populations in the Malheur Recovery Unit are considered "depressed." The population of adult bull trout in the North Fork Malheur River is estimated between 250 and 300 (USFWS 2002).

North Fork Malheur River and Beulah Reservoir

Bull trout were documented by angler harvest in Beulah Reservoir as early as 1959. Recent life history studies provide extensive data on spawning locations and seasonal migrations of bull trout in the North Fork Malheur River (Gonzales 1998; Schwabe et al. 2000). The ODFW initiated sampling efforts in Beulah Reservoir in the spring of 1994, capturing two fish. The ODFW analyzed 81 scale samples from bull trout collected from Beulah Reservoir and the tailrace of the reservoir from 1994 to 2000. These bull trout had fork lengths from 226 and 546 mm and ranged in age from 3 to 8 years old (see Figure 6-10).

Over 75 percent of the bull trout collected from Beulah Reservoir were 4- and 5-year-old fish. Bull trout younger than 3 years have not been documented in the reservoir. Past sampling methodology in the reservoir may not effectively detect a smaller population of age 2 bull trout. In May 2002, a screw trap located less than 0.5 mile upstream from the reservoir pool in the North Fork Malheur River captured two bull trout with fork lengths of 119 and 162 mm. These are potential candidates for age 2+

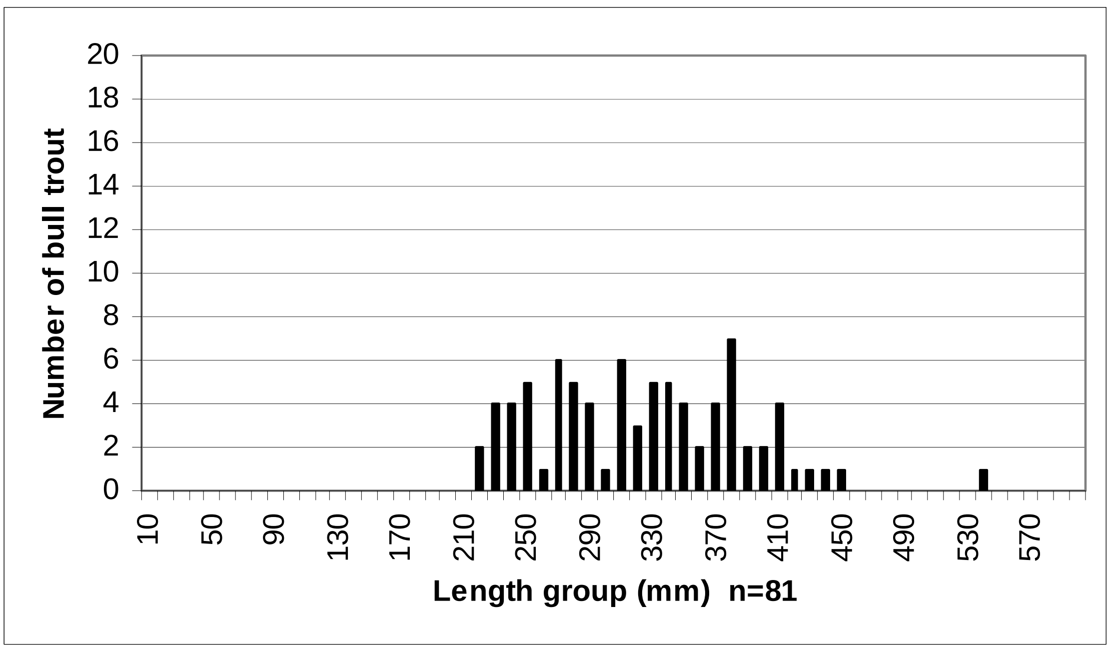

Figure 6-10. Length frequency histogram for bull trout collected in Beulah Reservoir between 1994 and 2000 (Schwabe and Perkins 2003).

and 3+ bull trout, but age class analysis on these fish has not been completed (Schwabe 2003).

Overall, water quality conditions appear to be acceptable during the periods that bull trout are present in the reservoir under past and current reservoir operations. Adult and subadult bull trout may inhabit the reservoir during the fall, winter, and early spring but may exhibit an adfluvial behavior pattern to avoid potential stresses, such as increased water temperature and limited dissolved oxygen (Petersen and Kofoot 2002). It appears that most bull trout, even those not ready to spawn, migrate upstream. Cold water refugia for bull trout are not available in Beulah Reservoir from early to mid-July until early October (USBR 2002), a period when migratory bull trout have left the reservoir and are in the upper watershed near spawning tributaries. Dissolved oxygen levels are also below levels deemed suitable for bull trout during the summer months.

Radio-tagging studies showed that bull trout moved upstream from overwintering areas in Beulah Reservoir into the North Fork Malheur River from mid-April until late May in 1999 (Schwabe et al. 2001). By June, tagged fish were well distributed in the North Fork Malheur River between Beulah Reservoir and the spawning areas. By early August, the majority of tagged fish had moved upstream from the confluence with Crane Creek at RM 42.8 and some had moved into spawning tributaries by mid-July. The peak for migration into spawning tributaries occurred by mid- to late-August (Schwabe et al. 2001). Downstream migration of adult bull trout from spawning tributaries occurred in late September, with a return to Beulah Reservoir between late October and mid-December (Schwabe et al. 2000, 2001). Past and current operations of Agency Valley Dam have not adversely affected migratory corridors upstream from Beulah Reservoir in the upper North Fork Malheur River basin.

Bull trout genetic samples were taken in 1995 from a North Fork Malheur River tributary. Results suggest that bull trout populations from the John Day River basin and northeastern Oregon, including the Malheur River basin, comprise a major genetic lineage (Spruell and Allendorf 1997 in USFWS 2002). Further analysis by Spruell et al. (2002 in USFWS 2002) indicate Malheur River bull trout are more genetically similar to bull trout populations from the Boise, Idaho, and Jarbidge, Nevada, drainages than to other populations in Oregon, and these three populations form a cluster within the Snake River group.

Brook trout have not been documented in the North Fork Malheur River, but a population is in the mainstem Malheur River subbasin. Buchanan et al. (1997) state that “anecdotal evidence suggests the brook trout were stocked by the Oregon Game Commission and volunteers in the high lakes of the Strawberry Mountains during the 1930s.”

Spawning surveys were initiated in the North Fork Malheur River upstream from Beulah Reservoir in 1992 to determine the time and location of spawning bull trout

(Buchanan et al. 1997). Spawning generally occurs from late August through late September. Standardized redd counts from 1996 through 2000 showed an increasing trend (see Table 6-4) from less than 50 to more than 150 redds for the North Fork Malheur population (NPCC 2002) but have recently declined since 2001 (Perkins 2004).

As shown in Table 6-4, several tributaries and the mainstem had the highest redd counts in 2000 since surveys started in 1992. Good water years and the prohibited take of bull trout might be attributable to the increase from 1992 to 2000. The North Fork Malheur River basin, upstream from Beulah Reservoir, had a "no-bait" restriction imposed in 1999 in an effort to increase the survival rate of bull trout captured and released by anglers. Recent declines in observed redds between 2001 and 2003 may be attributable to drought conditions.

From 1950 to 1987, the North Fork Malheur River, its tributaries, and Beulah Reservoir were chemically treated 6 times. In addition, chemical poisoning projects conducted between 1950 and 1987 on the North Fork Malheur River may have killed bull trout, but there is no record of bull trout mortalities (Bowers et al. 1993 in NPCC 2002). Reclamation is not aware of any contaminants that may be present in Beulah Reservoir.

Beulah Reservoir provides overwintering and foraging habitat for migratory bull trout in the North Fork Malheur River. Subadult or adult bull trout likely reside in Beulah Reservoir during winter months (Schwabe et al. 2000). During residence, bull trout are feeding on fish, including stocked rainbow trout, and are exposed to temperatures, dissolved oxygen, and other conditions that change with season or reservoir operation

Table 6-4. Bull trout redd counts in the North Fork Malheur River watershed from 1992 to 2003.

Year	Redds	Reach Length (miles)	Redds per Mile	Population Estimate
1992	2	9.2	0.2	
1993	8	28.2	0.3	
1994	13	24.1	0.5	
1995	9	24.0	0.4	
1996	38	22.3	1.7	80
1997	64	17.6	3.6	134
1998	74	22.6	3.3	115
1999	115	22.3	5.1	242
2000	150	22.3	6.6	321
2001	125	21.5	5.3	263
2002	99	15.4	6.4	208
2003	63	15.4	4.1	126

(Petersen and Kofoot 2002). Limnological data collected by Reclamation (USBR 2002) indicated that under past and present operating conditions, no cold water refugia exists in Beulah Reservoir for bull trout from early to mid-July until early October. Dissolved oxygen levels are also below levels deemed suitable for bull trout during the summer months (USBR 2002). These reservoir conditions result in most, if not all, bull trout migrating out of Beulah Reservoir in the spring to seek cooler water temperatures and spawning habitat. These migratory bull trout are important to the persistence and stability of the North Fork Malheur River population because they may represent unique genetic resources and because large migratory individuals are more fecund than smaller, resident stream fish (Petersen et al. 2003).

Beulah Reservoir has no designated minimum pool, and all the storage space is usable for irrigation and flood control. Except for years when Beulah Reservoir is drained, fish habitat for other aquatic species (including bull trout prey base) is available. Studies conducted between May and late November during 2001, a dry year, indicated potentially high abundances of available prey for bull trout (Petersen and Kofoot 2002).

Summer drawdown and low fall reservoir levels has discouraged growth and reproduction of aquatic invertebrates and plants; this has reduced the productivity of the reservoir and has limited the development of the fish food base for bull trout. Chlorophyll a levels measured from 1999 through 2002 remained low in the winter (when bull trout are present) and spike during the summer and fall (when bull trout are absent). This coupled with low nutrient levels, nitrogen, and total phosphorous concentrations indicate that the reservoir's past and current operations have led to a moderately productive reservoir relative to its ability to support communities of flora and fauna. However, annual recruitment of prey base species from the North Fork Malheur River and Warm Springs Creek have helped ameliorate some of the effects of reservoir fluctuations on the bull trout prey base.

Between 1955 and 1970, Beulah Reservoir was emptied three times (1955, 1961, and 1968) and was treated with rotenone in attempts to remove "trash fish." The relative abundance of common species increased fairly rapidly in between 1957 and 1960 and again between 1966 and 1967, although there was considerable year-to-year variation (Petersen et al. 2003). Since 1936, Beulah Reservoir was drawn down to minimum water levels, or run-of-the-river levels, in summer months during several years. Water levels were at a minimum (less than 1,000 acre-feet or run-of-the-river) for at least one month in 1950, 1973, 1977, and for several years between 1987 and 2003. In 2001, a low water year, Reclamation leased 2,000 acre-feet of water from the Vale Oregon Irrigation District to prevent the reservoir from being completely drained. Though this volume of water was also available in 2002, the reservoir was completely drained in 2002 (and again in 2003) in an effort to control illegally introduced white crappie in Beulah Reservoir.

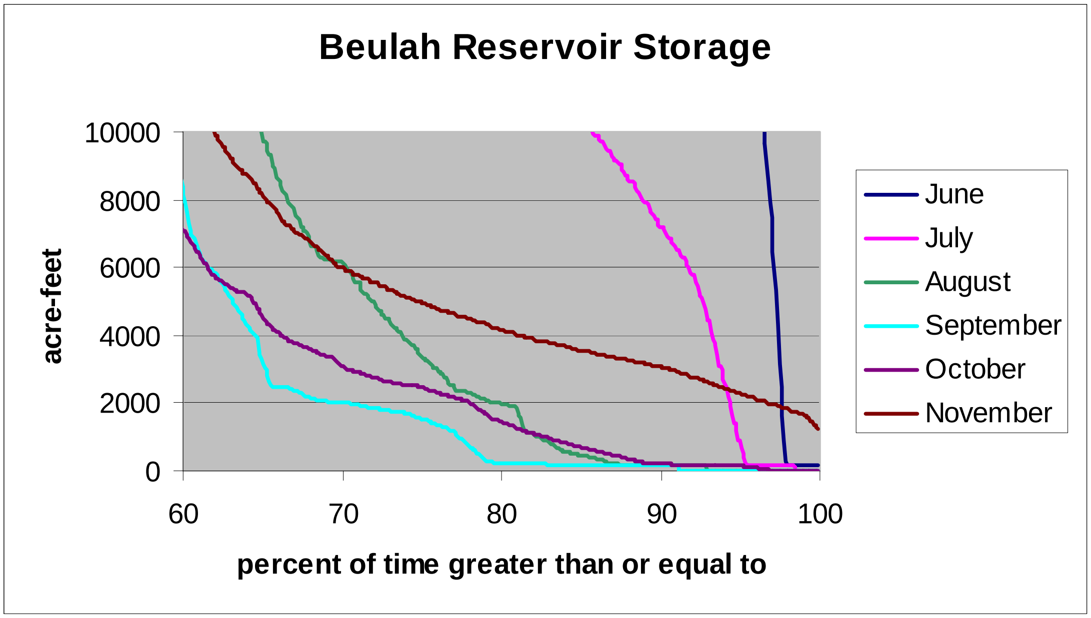

Figure 6-11. Exceedance curve for water storage at Beulah Reservoir from June through November, 1970 through 2003.

Figure 6-11 shows that between 1970 and 2003, the reservoir was drawn down to or below 2,000 acre-feet 2 percent of the time for June, 6 percent for July, 20 percent for August, 30 percent for September, 22 percent for October, and 3 percent for November. However, since migratory bull trout do not return to Beulah Reservoir until late October, and releases for irrigation end around October 15, it appears that the prey base recolonizes with contributions from the North Fork Malheur River and Warm Springs Creek immediately when refill begins. Petersen et al. (2003) indicate that historically, gill net catches of various species in Beulah Reservoir following a reservoir drawdown to river level appear to lag from 1 to 3 years. Beulah Reservoir has been drawn down to this river level in 1988, 1990, 1991, 1992, 1994, 2002, and 2003. Petersen et al. (2003) conclude that the fish community in the Beulah Reservoir vicinity is resilient to repeated reservoir drawdowns.

According to Petersen et al. (2003), Beulah Reservoir fish sampling between May and November in 2001 and between April and July in 2002 yielded 1,330 and 549 individuals of other species (including rainbow trout, suckers, dace, and shiners), respectively, but no bull trout. This lack of bull trout collection may indicate that their numbers are extremely low or that they migrate out of the reservoir prior to sampling efforts (Petersen et al. 2003). Based on temperatures observed and preferences noted in the literature for bull trout, it was not surprising that none were captured.

The Burns Paiute Tribe and the ODFW, with funding from Reclamation, conducted a radiotelemetry study of bull trout at Beulah Reservoir from 1998 (Gonzales 1998) to 1999 (Schwabe et al. 2000). The purpose of the study was to assess life history characteristics and document entrainment through Agency Valley Dam. The significant findings from this study are:

1. Adult bull trout migrate from Beulah Reservoir into the North Fork Malheur River from March through June. During the first year of study, all radio-tagged bull trout (except the two that were lost) left Beulah Reservoir and migrated to upstream locations. In 1999, bull trout that were captured in the tailrace of Agency Valley Dam, radio tagged, and then released in Beulah Reservoir, migrated upstream to known spawning tributaries.
2. The North Fork Malheur River upstream from Beulah Reservoir has three unscreened diversions that operate during periods when bull trout are migrating through the area. Telemetry studies showed that these diversions either delayed the migration of bull trout, or likely resulted in bull trout mortality into an unscreened diversion (Schwabe et al. 2000).
3. In 1999, radio-tagged bull trout released in the tailrace tended to stay within 1.2 miles of the dam. Of the 39 bull trout that were radio tagged and released in the reservoir, 4 were entrained through the dam and/or over the spillway.
4. Mature adfluvial bull trout appear to reside in Beulah Reservoir for about 6 months, from November through June.

Water release over the spillway, whether during flood control operations or to pass inflow when the reservoir is full, has been a significant factor for bull trout entrainment. In 1999, large flood control releases over the spillway in the winter and spring were likely significant contributors to bull trout entrainment. As a result, spillway operations at Agency Valley Dam were changed in 2000. The Vale Oregon Irrigation District agreed to discharge up to 650 cfs of Beulah Reservoir water from the river outlet works, when possible, rather than the spillway, in an effort to reduce bull trout entrainment. Since the existing valves have a maximum release capacity of up to 650 cfs, releases greater than 650 cfs must be made through a combination of both valves and up to 350 cfs over the spillway. Releases greater than 1000 cfs are made exclusively over the spillway for safety reasons. Spillway releases generally occur during flood control operations from February through June.

Following the Agency Valley Dam operational change described above, there has been a substantial decrease in bull trout entrainment documented below Agency Valley Dam. With funding provided by Reclamation, the Burns Paiute Tribe has captured bull trout by angling in the tailrace of Beulah Reservoir since 1998. Captured fish are transported and released into Beulah Reservoir. Between mid-March and mid-June of 1999, 20 bull trout were angled in the tailrace and released above the dam. During the same period in 2000, after operations were changed, five fish were angled and then released above the dam. Since 2001, water levels in Beulah Reservoir have not resulted in spillway releases, and no bull trout have been captured by angling in the tailrace.

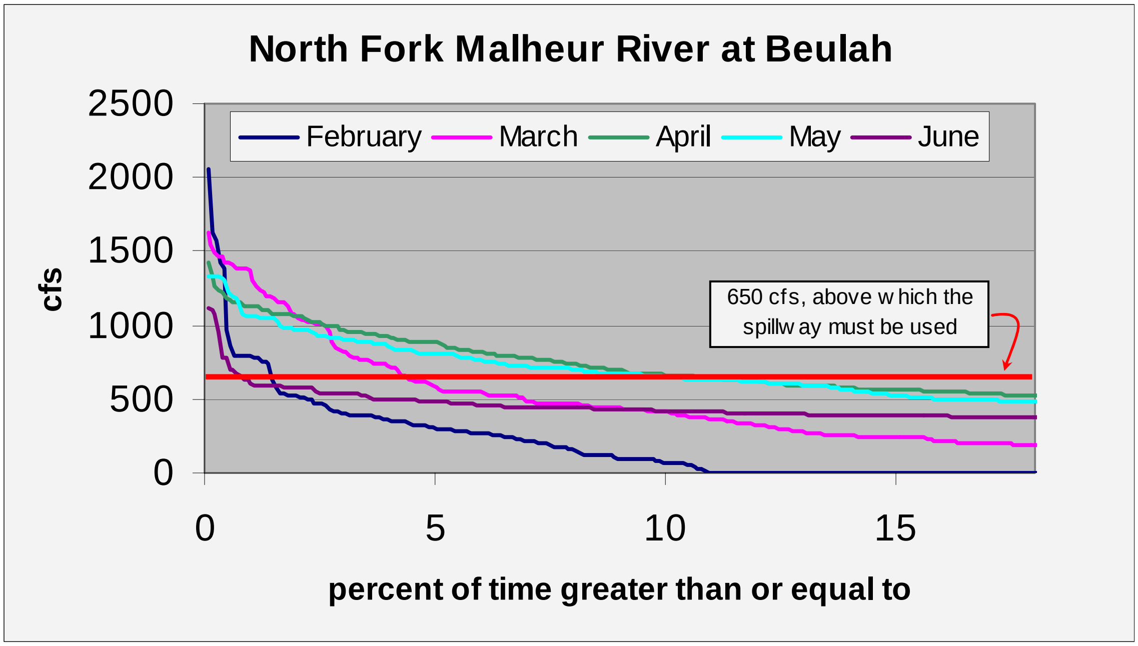

Figure 6-12. Exceedance curve showing the daily flow releases from Beulah Reservoir from February through June, 1961 to 2003.

However, these operational changes have not completely eliminated the risk of entrainment for bull trout. When more than 650 cfs must be released, and the spillway must be used, entrainment is possible. Telemetry studies have shown entrainment occurring during late winter/spring periods when bull trout are present in Beulah Reservoir. Figure 6-12 shows how often the releases from Agency Valley Dam into the North Fork Malheur River have exceeded certain flows during the months from February through June for the period of record from 1961 through 2003. Daily releases exceeded 650 cfs between 0.75 and 11 percent of the time. Daily releases exceeded 1,000 cfs from 0.3 to 2.8 percent of the time. During all the months of May, daily releases exceeded 650 cfs 11 percent of the time; daily releases exceeded 1,000 cfs 1.8 percent of the time.

With the exception of bull trout returned to Beulah Reservoir from annual trap and haul operations conducted in the tailrace, the lack of fish passage facilities at the dam means that bull trout entrained into the North Fork Malheur River are lost to the reproducing population. The survival of entrained bull trout is likely minimal to nonexistent during late spring to early fall. Entrained bull trout are unable to survive elevated water temperatures that are released from Beulah Reservoir during the July-to-September period. Should they go downstream, similar water conditions prevail in the mainstem Malheur River, and these bull trout also likely perish. Unscreened irrigation diversions also entrain and kill bull trout. In 1999, Schwabe et al. (2000) found one radio transmitter in an irrigation ditch approximately 6 miles below Agency Valley Dam.

Warm Springs Reservoir

Bull trout have not been documented in Warm Springs Reservoir. Low streamflow (less than 25 cfs during some summer periods), water temperatures as high as 26 °C from May through September, and a lack of fish passage facilities at irrigation diversions seasonally limit bull trout use from Warm Springs Reservoir to a distance of 35 to 40 river miles upstream (NPPC 2002).

Although Warm Springs Reservoir is over three times larger in volume than Beulah Reservoir, the variable water supply and demand for irrigation withdrawals cause year-to-year and season-to-season fluctuations. Warm Springs Reservoir has been emptied several times in the past, and this emptying is a part of normal operations.

Degraded riparian conditions along the mainstem Malheur River upstream from the reservoir cause high sediment loads. The Malheur Watershed Council and Burns Paiute Tribe (2004) state "the most heavily affected reach within the watershed is the upper Malheur River from the upper end of Warm Springs Reservoir to near Griffin Creek," a distance of about 40 miles. These high sediment loads that eventually reach Warm Springs Reservoir likely contribute to overall poor water quality conditions.

Past and current Warm Springs Reservoir operations have supported a functioning migratory corridor during the overwintering period when bull trout would be present. If present, migratory bull trout would likely return to the reservoir during the refill period and leave prior to unsuitable conditions.

Past and present reservoir operations have adversely affected the abundance of the food base, especially during years when the reservoir was completely emptied. The rapid summer drawdown of Warm Springs Reservoir likely reduced the productivity of the reservoir, providing little opportunity for growth and reproduction of aquatic invertebrates and plants, and the subsequent food base for bull trout. However, similar to Beulah Reservoir, it is likely that annual recruitment of prey species from the Malheur River has helped ameliorate some of the effects of reservoir fluctuations on the prey base.

6.7.4 Powder River Basin

Phillips Lake and Thief Valley Reservoir

Bull trout have not been documented in either Phillips Lake or Thief Valley Reservoir. While information is limited, water quality conditions near Mason Dam in Phillips Lake are good (Nowak 2004), and habitat for bull trout would likely be available through most of the year, with the exception of July through September in consecutive dry years. However, if migratory bull trout are present in the system, they would likely have moved to headwater locations during the July through September period.

Past and current operations at Mason and Thief Valley Dams have likely adversely affected the abundance of the food base, including bull trout forage fish and the zooplankton on which they prey. Phillips Lake and Thief Valley Reservoir have been drafted annually, and during drought conditions, the pools have been taken down to run-of-the-river conditions. The rapid summer drafting of these reservoirs for irrigation and low winter reservoir levels has reduced the productivity of the reservoirs. This has limited the production of aquatic organisms that may have reduced the food base available for bull trout, should they be present.

Information related to bull trout in Thief Valley Reservoir upstream to Mason Dam is scarce since bull trout have not been documented in this reach. Agricultural return flows to the Powder River between Baker City and Thief Valley Reservoir are laden with high levels of nutrients, including coliform levels that exceed state standards (Nowak 2004). Low streamflows from irrigation diversions likely elevate stream temperatures from June through September.

6.7.5 Snake River from Brownlee Reservoir to the Columbia River and the Columbia River below the Snake River Confluence

Chandler (2003) reported that bull trout found in the Oxbow Bypass Reach and Hells Canyon Reservoir appeared to be extremely low in abundance. Chandler (2003) also reported that bull trout populations found in the tributaries to the Complex upstream from Hells Canyon Dam had extremely low numbers, and that they were absent from lower reaches in the drainage. A significant number of bull trout captured in Oxbow and Hells Canyon Reservoirs showed signs of hybridization with brook trout, a result of bull trout and brook trout being present in the tributaries (Chandler 2003).

Below the Hells Canyon Complex, bull trout do not show any signs of hybridization with brook trout (Chandler 2003). Densities of bull trout downstream of Hells Canyon Dam, according to Chandler (2003) studies, “appeared higher” than in the Sheep Creek and Granite Creek drainages. However, Chandler (2003) also points out that densities of bull trout in both Sheep and Granite Creeks were extremely low based on Idaho Power surveys and IDFG long-term surveys.

Rieman and McIntyre (1993) indicated that bull trout populations are known to possess multiple life history forms with complex age structures, behavior, and maturation schedules throughout their range. Idaho Power bull trout studies conducted in the Hells Canyon Complex documented fluvial life histories, indicating that bull trout were migrating from tributaries within the Hells Canyon Complex to the mainstem (Chandler 2003). Migratory bull trout moving from the mainstem into tributaries upstream from Hells Canyon Dam averaged about 250 to 300 mm total length, whereas outmigrants below Hells Canyon Dam were much larger, at 350 to 450 mm total length (Chandler 2003).

Chandler (2003) found that bull trout use the Oxbow Bypass Reach and Hells Canyon Reservoir primarily during late fall and winter. Telemetry studies showed fluvial bull trout within the complex migrating to tributaries between April and early June, where they likely oversummer and then spawn in the fall (Chandler 2003).

Chandler (2003) documented bull trout below Hells Canyon Dam that exhibited "classic fluvial migrations" during the years that they monitored movement. Over half of the bull trout monitored made spring migratory movements downstream to the Imnaha River after wintering in the mainstem Snake River (Chandler 2003). Other bull trout that spawned the previous year but did not exhibit fluvial behavior may have remained in the Snake River throughout the summer. Fluvial bull trout were then documented returning to the Snake River, following spawning in the tributaries, sometime in November and December, and remained in the Snake River from January to April (Chandler 2003).

6.8 Effects Analysis

The area of analysis for bull trout includes these river reaches and reservoirs:

- In the Boise River system, Anderson Ranch Reservoir, the South Fork Boise River downstream from Anderson Ranch Dam to and including Arrowrock Reservoir, Lucky Peak Reservoir, and Mores Creek. This is exclusively in the action area for future O&M in the Boise River system.
- In the Payette River system, Deadwood Reservoir, the Deadwood River downstream from Deadwood Dam, and Lake Cascade. This is exclusively in the action area for future O&M in the Payette River system.
- In the Malheur River system, Beulah Reservoir, the North Fork Malheur River downstream from Agency Valley Dam, and Warm Springs Reservoir. This is exclusively in the action area for future O&M in the Malheur River system.
- In the Powder River system, Phillips Lake and Thief Valley Reservoir. This is exclusively in the action areas for future O&M in the upper and lower Powder River systems.
- In the lower Snake River, including Brownlee Reservoir, in and downstream from the Hells Canyon Complex. This is within the action areas for all 11 proposed actions.

Section 6.9 summarizes Reclamation's determination for each proposed action.

6.8.1 Boise River Basin

The Boise River basin is in the action area for future O&M in the Boise River system.

Arrowrock and Lucky Peak Reservoirs and the North and Middle Forks of the Boise River

Arrowrock Reservoir will continue to serve as an important overwintering and foraging area for migratory bull trout. Water quality, low reservoir volumes, and entrainment of fish will affect the quality and integrity of this adfluvial population and their habitat.

Due to the replacement of the ensign valves at Arrowrock Dam, water quality conditions will improve habitat and benefit bull trout that spend the summer in Arrowrock Reservoir (USBR 2003b). Releases from the new clamshell gates will keep minimum dissolved oxygen levels higher than historical values, though cold water refugia may be reduced slightly earlier in the spring than under past operations.

The drafting of Arrowrock Reservoir will also occur to a lesser extent than it has historically. Figure 6-13 shows a comparison between actual operations from 1990 to 2000 and simulated proposed action operations for a similar series of wet and dry years (the summary tables in Appendices C and D present numerical values for the historical and modeled reservoir contents at Arrowrock Reservoir). Similar to other systems (May et al. 1988), conditions in Arrowrock Reservoir will most likely continue to limit reservoir productivity and fish populations.

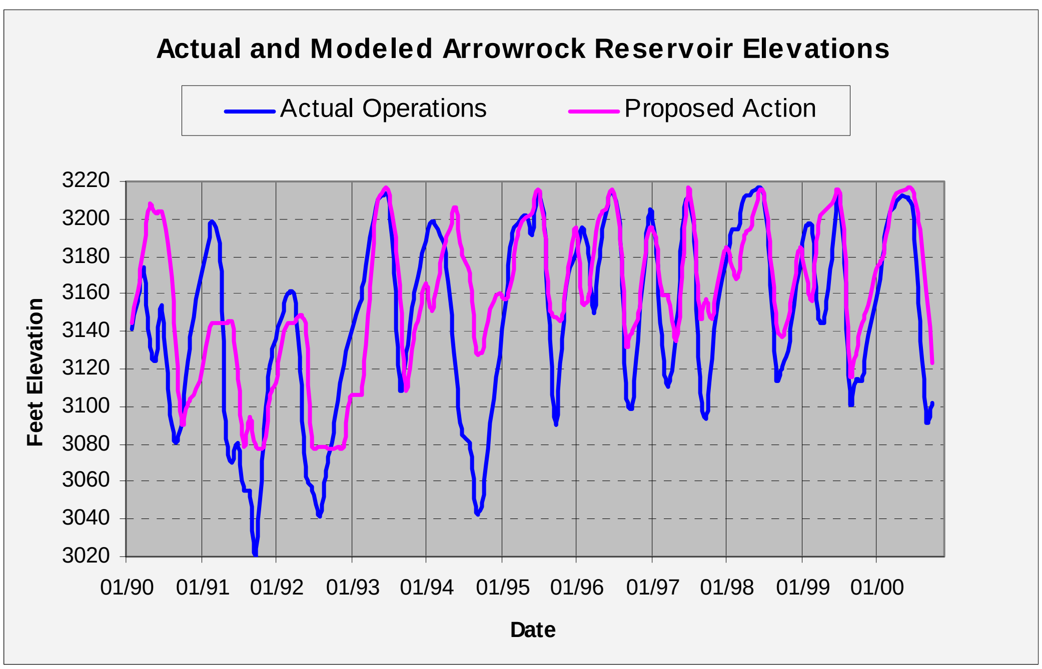

Figure 6-13. End-of-month Arrowrock Reservoir water surface elevations for actual operations from 1990 to 2000 and simulated proposed action operations.

Arrowrock Reservoir's refill operations, which begin on Labor Day under normal water levels, will continue to provide adequate reservoir volumes to support migratory bull trout during the fall migratory period. However, under more extreme water conditions, reservoir elevations may fall to a level low enough to cause harm to bull trout as they enter the reservoir in the fall (September 20 is the earliest bull trout have been documented entering the reservoir). Salow and Hostettler (2004) found that when the reservoir elevation near Irish Creek fell below elevation 3,100 feet (38,840-acre-foot volume), bull trout mortality rates substantially increased from predation by raptors and channel degradation (the extreme conditions cited in Salow and Hostettler (2004) where the reservoir was drafted to a volume of 1,500 acre-feet would not occur under the proposed action). The model predicts the September and October end-of-month reservoir elevation will be at least 3,100 feet over 95 percent of the time. In those 5 percent of years when the reservoir elevation falls below 3,100 feet, bull trout are likely to be adversely affected due to the loss of cover and increased exposure to predators.

High volumes of water discharged from the reservoir surface or just below the reservoir surface during the time when bull trout are using the reservoir may also adversely affect bull trout populations. Salow and Hostettler (2004) found that the rates of bull trout entrainment increased when discharge from the dam occurred within 20 feet of the surface and exceeded 695 cfs. These types of conditions may occur during three general operating seasons. First, entrainment may occur during the irrigation season when discharge is greater than 695 cfs and the reservoir water surface elevation is near or below elevation 3,111 feet; or secondly, during winter operations under these same discharge and reservoir surface elevation conditions. Finally, entrainment may occur when water is discharged over the dam's spillway (typically during spring flood control operations).

The model predicts that winter discharge from October through February will exceed 695 cfs about 43 percent of the time. However, the reservoir's water surface elevation is predicted to be near or below 3,111 feet less than 6 percent of the time. Therefore, entrainment through the clamshell gates in winter is expected to rarely occur.

Operations of Arrowrock Dam to provide for irrigation when the reservoir is at or near 3,111 feet in July and August have caused entrainment to occur. Most bull trout in the Boise River basin upstream from Arrowrock Dam and the South Fork Boise River below Anderson Ranch Dam spend the summer in regulated or free-flowing riverine habitats. However, in past studies, a small proportion of fish have been documented to move into the reservoir in July or August for short periods of time and have become entrained (Salow and Hostettler 2004). Discharge from Arrowrock Dam during July and August is greater than 695 cfs 99 percent of the time and near or below water surface elevation of 3,111 feet about 95 percent of the time. Based on Salow and Hostettler (2004), Reclamation anticipates 2 percent of bull trout that overwinter in Arrowrock Reservoir and the South Fork Boise River downstream from Anderson Ranch Dam would become entrained under these conditions.

During March-through-June flood control operations, entrainment is most probable when the surface spillway passes runoff that exceeds the clamshell gates' capacity. The newly installed clamshell gates have a combined discharge capacity of 6,364 cfs (Bachman 2004). Water will be discharged over the spillway when the reservoir water surface elevation is at least 3,211 feet and reservoir inflow exceeds the gates discharge capacity of 6,364 cfs. The model predicts that Arrowrock Reservoir will be at surface elevation 3,211 feet 55 percent of the time during the spring runoff period. However, the clamshell gates' discharge capacity is predicted to be exceeded just 27 percent of the time for this same period. Therefore, conditions conducive for entrainment are estimated to occur in 27 percent of years for the proposed action. Studies of entrainment in 2002 and 2003 indicate that 4 to 16 percent of the adfluvial bull trout population in Arrowrock Reservoir could be entrained under these conditions.

Entrainment of bull trout through Arrowrock Dam is likely to adversely affect the bull trout population above the dam through the loss of adult spawning fish. However, efforts to reduce or eliminate entrainment from Arrowrock Dam may adversely affect bull trout in Lucky Peak Reservoir and Mores Creek as adult spawning fish are removed from the Lucky Peak pool prior to spawning. Whiteley et al. (2003) found no evidence that the Mores Creek population was a distinct or unique population, but that it was most closely related to fish from the upper Middle and North Forks of the Boise River. This infers that fish in the Mores Creek population were derived from fish entrained through Arrowrock Dam.

The model predicts Lucky Peak Reservoir will fall below 80,000 acre-feet less than 1 percent of the time during winter operations; this will provide substantial winter habitat for bull trout. However, the modeled conditions consider water used for irrigation and flood control. Conditions related to maintenance of Lucky Peak Dam and the powerplant are not incorporated into the model, are not part of the proposed action, and are outside of the scope of this consultation. The large-scale drafting events, which reduce productivity in Arrowrock Reservoir, could flush nutrients and zooplankton that increases productivity in Lucky Peak Reservoir. The clamshell gates will allow deeper releases of colder water into Lucky Peak Reservoir (USBR 2003b). These operations will benefit bull trout populations by increasing productivity, increasing prey availability, and reducing temperatures in Lucky Peak Reservoir.

South Fork Boise River below Anderson Ranch Dam

Salow and Hostettler (2004) found this reach of river to be important overwintering and summer refuge habitat for fluvial and adfluvial bull trout. This river reach also has rainbow trout and whitefish present, and both are important prey items for bull trout (Beauchamp and Van Tassell 2001) and important recreational species (Wade et al. 1977). Reclamation's proposed action includes minimum streamflow of 300 cfs from the fall through winter and 600 cfs from the spring through summer for the benefit and enhancement of resident fish. These minimum streamflow targets below Anderson Ranch Dam were administratively determined; the ramping rates for dam releases and the extent of the effect of the administratively determined flows have not been evaluated for the benefit to the downstream fishery. Bull trout may be adversely affected when low streamflows occur due to drought, when spillway use is necessary during flood control or for maintenance, and when large changes in discharge velocities are made.

Figure 6-14 shows releases at Anderson Ranch Dam for the period from 1994 to 2000 and simulated releases for the proposed action for a similar series of wet and dry years. During a series of consecutive dry years, Reclamation may not be able to meet minimum 300-cfs winter instream flow targets. The model predicts this may occur in about 3 percent of years. Instream flows of at least 114 cfs are expected during these very dry years.

Very low streamflows may increase mortality in bull trout and their prey by the loss of available overwintering habitat. Low streamflows promote the formation of frazzle ice, which can plug fish gills (Annear 1987), limit aquatic insect production in riffle areas, restrict fish movement, and decrease the carrying capacity of the river, especially for fry and juvenile fish, which survive best in backwater and side channel areas with good cobble cover.

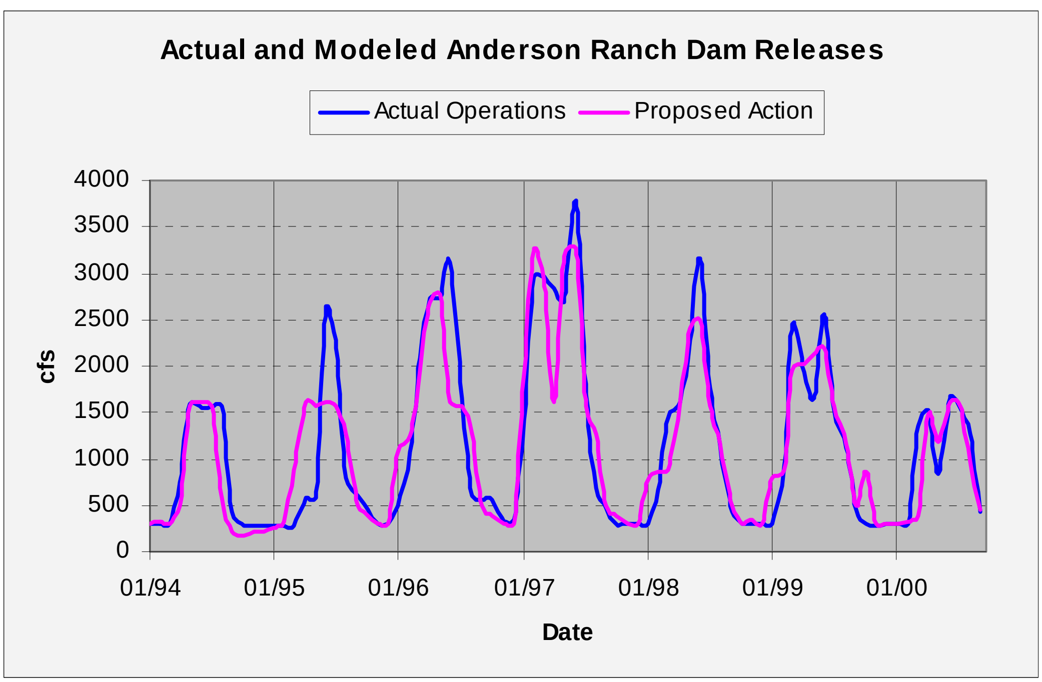

Figure 6-14. Monthly average releases from Anderson Ranch Dam from 1994 to 2000 and the simulated proposed action for similar water conditions.

Forty-four percent of fish tagged in the North and Middle Forks of the Boise River upstream from Arrowrock Reservoir overwintered in the South Fork Boise River downstream from Anderson Ranch Dam (Salow and Hostettler 2004). Reclamation estimated that this 44 percent of overwintering bull trout could be adversely affected when winter streamflows are low (Salow and Hostettler 2004).

As discussed in Section 6.7.1, rapid changes in reservoir discharge velocities may adversely affect bull trout and their prey that occupy the South Fork Boise River downstream from Anderson Ranch Dam (see USBR 2004b for specific rates). The loss of a natural hydrograph and thermal regime has not been studied in the South Fork Boise River, and magnitude of the effect is unknown. The release rates specified remain unchanged from past operations. Routine maintenance requiring the use of the spillway can also adversely affect bull trout and their prey by increasing water temperatures. Routine maintenance activities vary in timing and duration, and Reclamation will discuss these annually with the USFWS to determine necessary measures to reduce harm to bull trout.

Anderson Ranch Reservoir

Three factors have the potential to affect adfluvial bull trout at Anderson Ranch Reservoir: water quality, the subsequent reduction in the prey base, and entrainment through the dam. Figure 6-15 shows reservoir volumes from 1991 to 2000 and simulated volumes for the proposed action for a similar series of wet and dry conditions.

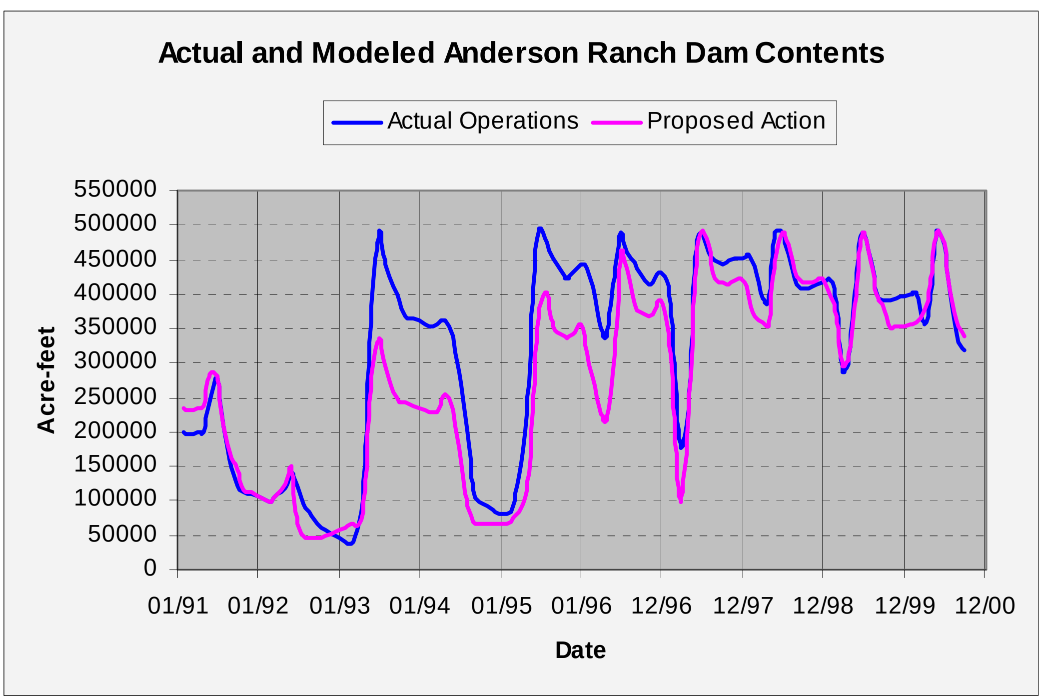

Figure 6-15. Monthly average Anderson Ranch Reservoir volume from 1991 to 2000 and simulated volume for the proposed action for similar water conditions (these include dead and inactive space).

Reclamation (2004a) found that maintaining a 62,000-acre-foot conservation pool at Anderson Ranch Reservoir maintains suitable water quality for adfluvial water suitable for adfluvial bull trout populations. The model predicts the reservoir will be at least 62,000 acre-feet about 98 percent of the time. During these 2 percent of years, reservoir contents will be about 49,000 acre-feet. Water quality problems will continue to occur only during multiple drought years when the water volume drops below the conservation pool and temperature and dissolved oxygen levels in the reservoir become unsuitable to bull trout. These conditions will most likely occur during July and August when most bull trout will have migrated to riverine habitat to spawn or over-summer (USBR 2004a).

Though water quality conditions may not directly affect bull trout in these late summer months, they can adversely affect kokanee trout (Megergle 2004), a principal prey item in many systems with self-sustaining kokanee populations (Vidergar 2000). Loss or reduction in the kokanee prey base could potentially adversely affect bull trout that overwinter in Anderson Ranch Reservoir. The model predicts the reservoir volume will be above 74,600 acre-feet, the lowest reservoir volume during the 2001 kokanee trout kill, about 97 percent of the time. However, water surface elevation and volume alone did not cause the conditions resulting in the 2001 fish kill. Reservoir volumes and elevations have been near or lower than the 2001 level without documented fish kills. Low wind levels (decreasing surface to bottom water exchange) and unusually high temperatures over several weeks may have also contributed to conditions resulting in the kokanee fish kill. These conditions have only been documented in 2001. Therefore, these events are considered rare, and the magnitude of effects would be short-term unless confounded by other conditions (introduced species or chemical treatments).

Under the proposed action, entrainment of bull trout from Anderson Ranch Reservoir to the South Fork Boise River will likely remain extremely low and is not likely to adversely affect bull trout using the reservoir. Entrainment has not been documented, though it may occur at low levels (Partridge 2000). The intake for the Anderson Ranch Dam outlet works and turbines is nearly 200 feet below the spillway crest. The depth of the intake, gradual releases of water from Anderson Ranch Dam, the reservoir's relatively large conservation pool, and the gradual fluctuation of reservoir content all most likely contribute to the low level of bull trout entrainment (Partridge 2000; Salow unpublished, Anderson Ranch Reservoir) and most likely other aquatic fauna.

Using the Anderson Ranch Dam spillway could cause higher levels of bull trout entrainment. Releases over the spillway can occur when the reservoir is nearly full at water surface elevation 4,195 feet. Generally, the spillway is used to maintain sufficient powerhead and prevent damage to the radial gates of the dam (when inflow would exceed the turbine capacity of 1,700 cfs). The model predicts the water surface elevation will be at or below 4,195 feet about 29 percent of the time during the months of April through June. The spillway has been used in 12 years since 1980, or approximately 50 percent of the time historically. The conditions for spillway use depend on both reservoir elevation and magnitude of reservoir inflow. The magnitude of any potential entrainment effects cannot be quantified because entrainment has not been documented at Anderson Ranch Dam.

Generally, conditions are adequate for bull trout survival in Anderson Ranch Reservoir. Adverse affects may occur in 2 percent of years when the conservation pool is not maintained, resulting in poor water quality conditions, and during flood control operations that use the spillway. Operations and conditions that will occur with the proposed action are expected to change little from past operations and conditions.

6.8.2 Payette River Basin

The Payette River basin is in the action area for future O&M in the Payette River system.

Deadwood River downstream from Deadwood Dam

Reclamation's proposed action includes a minimum streamflow target of 50 cfs below Deadwood Dam from the fall through winter for the benefit and enhancement of resident fish. Bull trout may be adversely affected when the discharges of water from the dam are low, unusually cold in temperature, unseasonably variable in temperature, or have large changes in discharge velocity.

Figure 6-16 shows releases below Deadwood Dam from 1991 to 2000 and simulated releases for the proposed action for a similar series of wet and dry years. Low winter

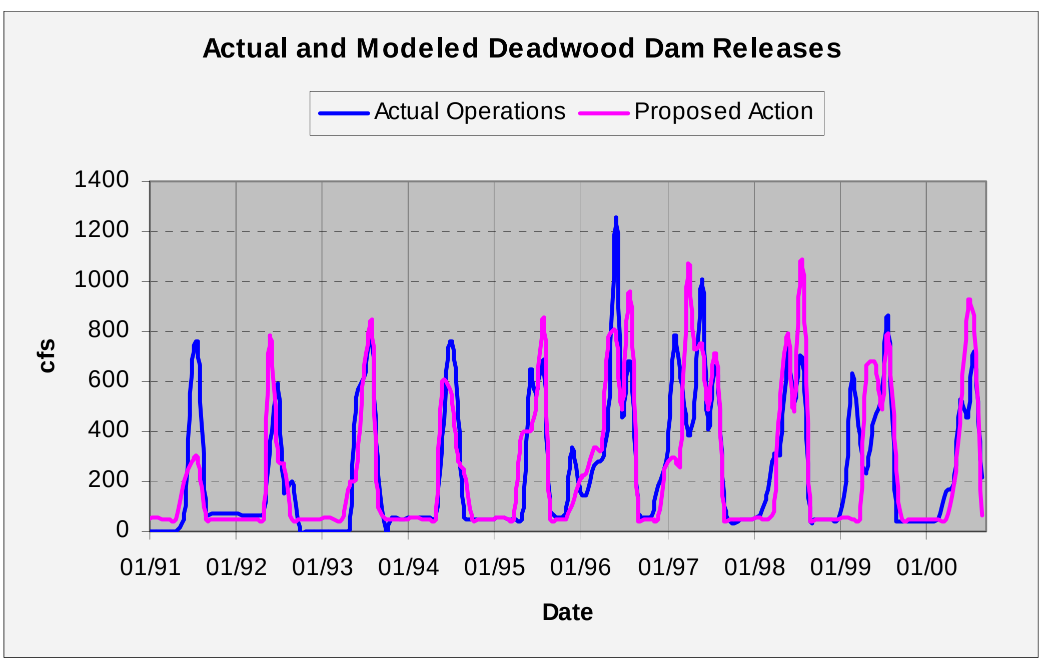

Figure 6-16. Monthly average releases from Deadwood Dam from 1991 to 2000 and the simulated proposed action for similar water conditions.

releases from Deadwood Dam may adversely affect bull trout. Until recently, Deadwood Dam releases were completely stopped during winter months to allow for water storage. Winter flow releases of 50 cfs began in the early 1990s. This rate is less than inflows to Deadwood Reservoir upstream and reduces overall habitat available to bull trout downstream from the dam. Low streamflows promote the formation of frazzle ice, which can plug fish gills (Annear 1987), and limits aquatic insect production in riffle areas. Lower water velocities and streamflows can restrict fish movement and migration and can reduce available habitat, especially for fry and juvenile fish, which survive best in backwater and side channel areas with good cobble cover.

Rapid changes in reservoir discharge velocities may adversely affect bull trout and their prey that occupy the Deadwood River downstream from Deadwood Dam (see USBR 2004b for specific discharge rates). No rates are currently specified for reducing discharge from Deadwood Dam, and under past operations, stranding of fishes and stream habitat dewatering has occurred. The loss of a natural hydrograph and thermal regime has not been studied in the Deadwood River and magnitude of the effect is unknown. The release rates specified remain unchanged from past operations.

Conditions that require use of the spillway for routine maintenance can also adversely affect bull trout and their prey by increasing water temperatures and reducing flow. These projects vary in timing and duration and will be discussed annually with the USFWS to determine necessary measures to reduce harm to bull trout.

Water temperatures in the Deadwood River due to releases from Deadwood Dam may adversely affect fluvial bull trout. The reservoir's very cold water releases probably reduce the ability for adequate metabolic function, including growth and reproduction in most fishes and other aquatic fauna. Densities of fish and other aquatic fauna have been observed to be very low (Allen 1998; Salow unpublished, Deadwood Reservoir). Under the proposed action, the changes between surface and deep releases of water through the dam will continue to cause temperature fluctuations and reduce the overall productivity within the river reach. During dry years, Reclamation will continue to be unable to ameliorate the effects of the cold temperature releases. Overall, the water temperatures in this reach will remain much colder and less variable than comparable watersheds.

Deadwood Reservoir

Two factors have the potential to affect adfluvial bull trout at Deadwood Reservoir: water quality and the subsequent reduction in the prey base, and entrainment at Deadwood Dam. Figure 6-17 shows past reservoir contents for the period from 1990

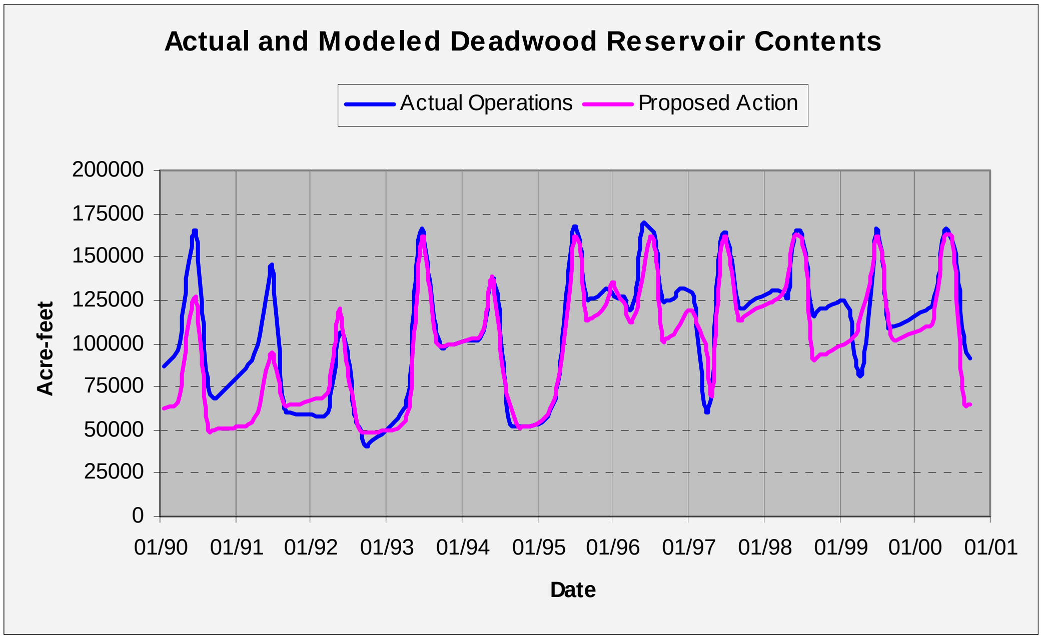

Figure 6-17. Monthly average Deadwood Reservoir contents from 1990 to 2000 and simulated contents for the proposed action for similar water conditions.

to 2000 and simulated contents for the proposed action for a similar series of wet and dry years.

The proposed action may result in low reservoir elevations, which may affect the bull trout prey base and may adversely affect fluvial and adfluvial bull trout in the reservoir during periods of multiple dry years. Reclamation has maintained a 50,000-acre-foot conservation pool since 1993. However, under the proposed action, Reclamation may reduce the conservation pool volume up to 10,000 acre-feet during multiple dry-year events. The model predicts this condition will occur in about 7 percent of years (during the month of September when reservoir elevations are lowest). The minimum reservoir volume would be about 46,000 acre-feet. Historically, Deadwood Reservoir has been less than 50,000 acre-feet during September in about 20 percent of years, and it has been emptied in some years. Minimum reservoir elevations under the proposed action will be significantly improved from past operations.

Densities of adfluvial bull trout are lower than past levels, possibly due to past drought, chemical treatment, and introduced species. The magnitude of the effects to bull trout of reducing the conservation pool cannot be accurately quantified with the data available.

Thermal conditions will usually be suitable for bull trout except in the late summer and early fall period when the reservoir is at or near the 50,000-acre-foot conservation pool, the dissolved oxygen levels become inadequate, and water temperatures begin to exceed bull trout tolerances (USBR 2004c). Removing additional water during this period may adversely affect aquatic fauna, including bull trout and kokanee. Kokanee are an important prey item for bull trout where they are present (Vidergar 2000). An adverse effect to kokanee in these extremely dry years will also likely adversely affect adfluvial bull trout in Deadwood Reservoir.

Entrainment is not likely to adversely affect bull trout at Deadwood Dam. Entrainment of bull trout from Deadwood Reservoir to the Deadwood River has not been documented, though some entrainment may occur. Under the proposed action, water will normally flow over the unregulated spillway in June or July. If patterns of adfluvial bull trout movement in this system parallel those of others, then the bull trout would generally be at the mouths of or have migrated into tributaries to spawn during June and July. However, movement and migration patterns of adfluvial bull trout have not been documented for the Deadwood River system.

In addition, the outlet works for Deadwood Dam are located about 130 feet below the spillway crest. During the fall and winter, Reclamation will operate the reservoir to maintain a minimum pool of 50,000 acre-feet and release 50 cfs to maintain streamflow downstream from the dam. Winter operations do not likely provide a high probability of entrainment for bull trout.

Reclamation has determined that the proposed action may affect and is likely to adversely affect bull trout overwintering in the Deadwood Reservoir when reservoir storage is less than 50,000 acre-feet in about 7 percent of years. Loss of overwintering habitat and poor water quality conditions could create unfavorable conditions for both bull trout and their prey. The effect of the action cannot be accurately estimated given the already low population densities of adfluvial bull trout.

Lake Cascade

Because bull trout have only been incidentally documented in Lake Cascade, and no upstream passage is currently available between spawning and rearing populations, Reclamation has determined there will be no effect on bull trout in Lake Cascade.

6.8.3 Malheur River Basin

The Malheur River basin is in the action area for future O&M in the Malheur River system.

Beulah Reservoir and the North Fork Malheur River

Under the proposed action, conditions in Beulah Reservoir will likely continue to limit reservoir productivity and fish populations. The year-to-year and season-to-season fluctuations in water supply and irrigation demand will continue. Summer drawdown and low fall reservoir levels will continue to limit the reservoir's productivity, discourage growth and reproduction of aquatic invertebrates and plants, and limit development of the fish prey base for adfluvial bull trout. Currently, there are no population estimates for bull trout in Beulah Reservoir and the North Fork Malheur River, and the extent of this effect on the population or habitat conditions is unknown.

Reclamation (2002) found that keeping Beulah Reservoir at full pool during summer months would not provide water quality suitable for adfluvial bull trout. This likely explains why most bull trout leave the reservoir in the spring and return after spawning late in the fall. In years when Beulah Reservoir is emptied, migratory bull trout may briefly return to Beulah Reservoir in the fall and then migrate back upstream where they overwinter in areas with an adequate food supply. Recent Burns Paiute Tribe trapping efforts in Beulah Reservoir may support this concept as very few bull trout have been collected from the reservoir during the 2002-2004 spring sampling period. In average water years, more bull trout were captured during spring sampling periods.

During drought periods, Beulah Reservoir adfluvial bull trout may be exhibiting similar feeding behavior to those Salow and Hostettler (2004) identified with Boise River bull trout that were overwintering in the South Fork Boise River rather than in Arrowrock Reservoir. Schwabe (2003) documented the adequate food supply in these upriver reaches of the North Fork Malheur River based on catch rates from a screw trap. The Burns Paiute Tribe fished a screw trap immediately upstream from Beulah Reservoir in the springs of 2002 and 2003 and caught numerous non-game fish species that would be considered prey base species for bull trout. This supports USGS findings (Petersen et al. 2003) of the fish community in the Beulah Reservoir vicinity being resilient to repeated reservoir drawdowns and that annual recruitment of prey base species from the North Fork Malheur River and Warm Springs Creek have helped ameliorate some of the effects of reservoir fluctuations on the bull trout prey base.

Though water quality conditions may not directly affect bull trout during the summer months, they can adversely affect the bull trout prey base. Loss or reduction in the bull trout prey base could potentially adversely affect bull trout that overwinter in Beulah Reservoir. Based on the historical record from 1970 to 2003, the reservoir would drop to 2,000 acre-feet in 7 percent of the years and would be emptied in 4 percent of the years. During this low volume period, bull trout would have left Beulah Reservoir in the spring to upstream locations to either spawn or over-summer; however, their prey base would still be affected.

Operational changes at Agency Valley Dam since 2000 resulted in less water being passed over the spillway that reduced but did not eliminate entrainment. Entrainment of bull trout from Beulah Reservoir to the North Fork Malheur River will likely remain low as long as all releases 650 cfs or less are made through the valves and not over the spillway. Using the spillway at Agency Valley Dam to pass reservoir inflows prior to 2000 likely resulted in higher levels of entrainment of bull trout. This might explain why 4 of 39 radio-tagged bull trout were entrained during a 1999 telemetry study when spring releases were passed over the spillway. Since 2000, releases over the spillway are likely to occur only when the valves exceed their release 650-cfs capacity. When total releases are less than 1,000 cfs, 650 cfs can be released through the valves and 350 cfs can be passed over the spillway. Releases greater than 1,000 cfs must be passed exclusively over the spillway.

Historical data from 1961 to 2003 showed that releases between February and June exceeded 650 cfs about 5.5 percent of the time and exceeded 1,000 cfs about 1.5 percent of the time. The conditions requiring spillway use depend on both reservoir elevation and magnitude of reservoir inflow. While the above percentages for releasing water over the spillway are small, there is still the opportunity for entrainment to occur. The magnitude of the effect of entrainment cannot be quantified because population estimates of bull trout in Beulah Reservoir have not been made. Entrainment of bull trout through Agency Valley Dam will continue and is likely to adversely affect the bull trout population above the dam through the loss of adult spawning fish. However, efforts to reduce bull trout entrainment from Agency Valley Dam following the change in releases (spillway to valve) identified in current conditions appear to be reducing entrainment based on fewer bull trout angled in the tailrace.

Conditions in the North Fork Malheur River downstream from Agency Valley Dam will likely continue to limit stream productivity and survivability of entrained bull trout. Bull trout that are entrained in the spring and not recaptured by trap and haul operations will likely perish.

Warm Springs Reservoir

Bull trout have not been documented in Warm Springs Reservoir, and Reclamation has determined there will be no effect on bull trout in Warm Springs Reservoir.

6.8.4 Powder River Basin

The Powder River basin is in the action areas for future O&M in the upper and lower Powder River systems. Bull trout have not been documented to occur in this basin, and Reclamation has determined there will be no effect on bull trout in the Powder River.

6.8.5 Snake River from Brownlee Reservoir to the Columbia River and the Columbia River below the Snake River Confluence

The Snake River downstream from Brownlee Reservoir and the Columbia River downstream from its confluence with the Snake River are in the action areas for all 11 proposed actions. This effects discussion considers the combined effects of these 11 actions.

The ability to ascertain or determine the effects of Reclamation's 11 proposed actions on bull trout is complicated by the presence and operation of Idaho Power's Hells Canyon Complex and the effects of Hells Canyon Complex operations on lower Snake River flow, water quality, and other environmental conditions. It is reasonable to expect that any measurable or tangible effect from Reclamation's proposed actions would be most pronounced in the Snake River upstream from Brownlee Dam and diminish with distance downstream from Brownlee Dam due to tributary inflow, the operations of Oxbow and Hells Canyon Reservoirs, and an array of other environmental and anthropogenic factors.

The model predicts that Brownlee Reservoir inflows will decrease in winter and increase in spring and summer. The decrease in average monthly inflow in the winter and early spring will be no more than 448 cfs less than flows under current operations. The model also predicts that during the driest years, Brownlee Reservoir inflows could increase by as much as 1,100 cfs in July (at the 90 percent exceedance level) compared to current operations. This is attributed to salmon flow augmentation.

These operational changes are not likely to have any measurable effect on bull trout and their prey base in the Hells Canyon Complex and downstream areas. The changes in Brownlee Reservoir inflows are relatively minor compared to existing inflows, and Brownlee Reservoir elevations (as well as Oxbow and Hells Canyon) are not likely to be affected at all since flow augmentation is passed through the three reservoirs. Changes in flows below Hells Canyon Dam would also be unlikely to have a measurable effect on bull trout, their prey base, and bull trout accessibility to spawning tributaries since changes would be very minor compared to existing flows.

6.8.6 Cumulative Effects

Bull trout are distributed primarily on Federal land, but private and state activities and management programs may affect bull trout and their habitats.

Private irrigation withdrawals from instream natural flow rights issued by the State of Idaho are not likely to adversely affect bull trout populations in the action area within the Boise and Payette River watersheds. The Deadwood River contains few known diversions with most of the watershed located entirely on Federal land. Most private diversions in the Boise River upstream from Lucky Peak Dam are not closely monitored; however, most are small private diversions (less than 1 cfs) along tributary streams that remove an estimated 50 cfs from the system annually (Sisco 2004). The North Fork Malheur River upstream from Beulah Reservoir has three unscreened diversions that operate during periods when bull trout are migrating through the area (upstream and downstream). Telemetry studies showed that these diversions either delayed the migration of bull trout or likely resulted in bull trout mortality into an unscreened diversion (Schwabe et al. 2000).

Fisheries management actions, such as stocking, angling regulations, and enforcement, may adversely affect prey species and bull trout populations. The States of Idaho and Oregon conduct fisheries management actions, including harvest regulation and stocking, in the Boise, Payette, Powder, and Malheur River watersheds. The demand for recreational opportunities in the Boise, Payette, and Malheur River basins is expected to increase as local population centers in the Treasure Valley continue to increase and expand. Population increases result in additional pressures on reservoir and stream fishing in the action area. Increased angling can affect the habitat of bull trout. Angling can also directly interfere with the species in the form of poaching and the inability of anglers to properly identify and release bull trout (Salow and Hostettler 2004; Haynes 2003).

6.9 Effects Conclusion

6.9.1 Future O&M in the Boise River System

Reclamation has determined that future O&M in the Boise River system may affect and is likely to adversely affect bull trout in Anderson Ranch Reservoir, the South Fork Boise River, and in Arrowrock Reservoir.

Adverse effects to bull trout at Anderson Ranch Dam will occur in 2 percent of years when the 62,000-acre-foot conservation pool is not maintained.

Adverse effects to up to 44 percent of overwintering bull trout will occur in the South Fork Boise River when winter streamflows fall below 300 cfs in 3 percent of years. Adverse effects to bull trout in the South Fork Boise River will also occur from water temperature changes when Anderson Ranch Dam spillway discharges occur during flood control operations and when there are large changes in discharge velocities. Adverse effects to bull trout at Arrowrock Reservoir will occur from mortality and entrainment. Bull trout mortality will occur in 5 percent of years when the reservoir falls below 3,100 feet elevation and causes a loss of cover and an increase in exposure to prey. Entrainment will occur during winter operations in 6 percent of years, during March-through-June flood control operations in 27 percent of years (with an estimated 4 to 16 percent of Arrowrock Reservoir adfluvial bull trout being entrained, and in July and August during 95 percent of years (up to 2 percent of bull trout may become entrained during July and August operations).

6.9.2 Future O&M in the Payette River System

Reclamation has determined that future O&M in the Payette River system may affect and is likely to adversely affect bull trout in Deadwood Reservoir and in the Deadwood River below Deadwood Dam.

Adverse effects to bull trout in Deadwood Reservoir will occur in 7 percent of years when the 50,000-acre-foot conservation pool is not maintained (during late summer and early fall).

Adverse effects to bull trout in the Deadwood River below Deadwood Dam will occur from unfavorably low (very cold) water temperature releases from the dam that cause large variations in water temperatures, from large variations in discharge velocities, and from low winter streamflows. These will occur in all years, and will adversely affect bull trout, its habitat, and its prey.

6.9.3 Future O&M in the Malheur River System

Reclamation has determined that future O&M in the Malheur River system may affect and is likely to adversely affect bull trout in Beulah Reservoir and in the North Fork Malheur River below Agency Valley Dam. Adverse effects to bull trout in Beulah Reservoir will occur through loss of reservoir productivity when the reservoir is annually drawn down and occasionally emptied in 4 percent of years. Adverse effects to bull trout will also occur when the spillway must be used at flows greater than 650 cfs in 5.5 percent of years. Water temperatures from reservoir releases are not conducive for bull trout entrained into the North Fork Malheur River below Agency Valley Dam.

6.9.4 Combined Effects of all Proposed Actions in the Snake River from Brownlee Reservoir to the Columbia River and in the Columbia River below the Snake River Confluence

Reclamation has determined that the 11 proposed actions may affect but are not likely to adversely affect bull trout in the Snake River from Brownlee Reservoir to the Columbia River and in the Columbia River below the Snake River confluence. The operational changes are not likely to have any measurable effect on bull trout, their prey base, or accessibility to their spawning tributaries.

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